AMENDMENTS TO THE JUNE 26, 1987 WORK PLAN FOR THE ORTHO-CHEVRON CHEMICAL PLANT MARYLAND HEIGHTS, MISSOURI

REVISION 1

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March 8, 1989

WCC Project 13C114-21

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1.0 INTRODUCTION

At the request of the U.S. Environmental Protection Agency (USEPA), Chevron Chemical Company and its consultant, Woodward-Clyde Consultants (WCC) submitted a Work Plan to USEPA to address and guide proposed field and office studies concerning Chevron's Maryland Heights, Missouri facility. The Work Plan, dated June 26, 1987, provided for an investigation to characterize the site followed by various assessments to select appropriate and cost effective remedial responses.

The proposed field studies described in the Work Plan were completed in 1987 and the new data were summarized in a revised Site Characterization Report (SCR) dated February 10, 1988. At Chevron's request, the SCR was discussed in conference on June 7, 1988 with representatives from USEPA and their subcontractor, Tetratech, Chevron Chemical Company, and WCC. During the meeting, WCC presented an overview of the data generated during the July 1987 investigation and observed trends in ground water quality at the site. Changes to the scope of work and schedule described in the Work Plan were also discussed. It was agreed that USEPA would formally approve the Work Plan and review and comment on any proposed changes and/or amendments to the Work Plan prior to Chevron's proceeding with further work.

In a letter to Chevron Chemical Company dated June 24, 1988 USEPA provided Chevron with a list of comments to be addressed in the amendments to the Work Plan. The USEPA also requested that a Risk Assessment and Response Action Plan be prepared for the site. Chevron responded in a letter dated July 21, 1988 by providing a list of action items and schedule for future studies.

Based on the recent discussions between USEPA and Chevron, changes to the existing Work Plan are required to update the Work Plan and incorporate the items requested by USEPA. The purpose of this document is to update the

Work Plan and provide information necessary to guide the proposed additional field and office studies concerning the Maryland Heights, Missouri facility.

The amendments presented in this document are intended to supplement the existing Work Plan. The provisions of the Work Plan dated June 26, 1987 remain in effect except as amended or clarified below. It is assumed that the reader is familiar with the Work Plan dated June 26, 1987 and the SCR dated February 10, 1988.

The future studies at the site will be directed towards implementation of long-term remedial responses. Certain remedial responses will be implemented following approval of the Work Plan amendments. These responses will include:

- o design/construction of a storm sewer to manage surface water run-on within the western portion of the site;
- o design/construction of a low permeability surface cap for unpaved areas of the site. The cap will be designed to reduce surface water infiltration and eliminate the potential for wind blown contamination.
- o replacement of the existing storm water retention pond. This facility will be replaced by a larger containment basin for temporary storage of storm water and fire water. The new facility will be designed with a low permeability liner to reduce seepage losses from the basin.

Additional long-term remedial responses may be required to address ground water concerns and public health issues related to off-site contamination of surface soils. To better address these issues, a supplemental field investigation is planned to better define the horizontal and vertical extent of off-site contamination in soil and ground water (if any). The field investigation will also include ambient air sampling to evaluate potential airborne contaminants. The data contained in the revised SCR dated February 10, 1988 and additional information obtained from the supplemental field investigation described in this document will be used to

prepare a baseline public health evaluation (endangerment assessment) for the site. The EA will focus on public health concerns related to off-site contamination of soil and ground water. Ultimately, the findings of the EA will be used to prepare a Response Action Plan (RAP) for the site.

In summary, the major tasks addressed by this Work Plan amendment include:

- o supplemental field investigation;
  - off-site soil sampling
  - on-site soil sampling
  - monitoring well installation
- o continuation of quarterly ground water monitoring;
- o preparation of an endangerment assessment;
- o identify/design interim responses for off-site contamination;
- o implement interim responses;
- o preparation of a response action plan; and
- o design/construction of selected long-term remedial responses
  - surface water run-on controls
  - surface water infiltration controls
  - containment basin replacement;
- o design/implement selected responses for ground water and off-site soil contamination.

The major tasks are listed in Figure 1 with the estimated schedule for implementation of the tasks. The schedule presented in Figure 1 replaces Figure 10 in the original Work Plan and supercedes the schedule discussed in USEPA's letter dated June 24, 1988 and the July 21, 1988 Chevron letter to USEPA.

2.0 SITE DESCRIPTION AND BACKGROUND

The reader is referred to the revised SCR dated February 10, 1988 for a detailed summary of the site and investigations conducted through 1987.

3.0 PROPOSED FIELD INVESTIGATION

A supplemental field investigation is proposed to further refine the site characterization and to provide data necessary for the endangerment assessment (EA). The field investigation will include on-site and off-site activities as described below.

3.1 ON-SITE ACTIVITIES

The supplemental field investigation will consist of three primary tasks:

- o quarterly ground water monitoring;
- o additional soil sampling within the western portion of the site to include the present containment basin and the north/south drainage ditch; and
- o air sampling.

3.1.1 GROUND WATER SAMPLING

3.1.1.1 Objectives and Scope

Semi-annual ground water sampling will be implemented for the on-site wells that are currently a part of the quarterly ground water sampling network.

Quarterly ground water sampling will continue as described in the original Work Plan for the two wells installed off-site in 1987 (OWC-24 and OWC-25) and the two proposed off-site bedrock wells (OWC-26 and OWC-27) and the proposed off-site shallow well (OWC-28) to be installed as a part of this supplemental field investigation. Ground water sampling will continue until the effectiveness of the selected remedial responses are assessed.

Ground water samples collected from the on-site wells will be analyzed for the parameters listed in Table 1. Ground water samples collected from the

off-site wells on a quarterly basis for one year will be analyzed for the compounds listed in Table 1a.

If following one year of quarterly monitoring non-detectable levels of the compounds of interest have been observed, sampling frequency will be reduced to semi-annual. If following an additional year of semi-annual sampling, the compounds of interest remain below detectable levels, sampling frequency of the off-site wells will be reduced to annual.

Chevron will evaluate the analytical results from the off-site wells individually. If following a reduction in sampling frequency any of the compounds of interest are detected in one of the off-site wells, the well will be put back on a quarterly sampling schedule. The well will remain on a quarterly schedule until four consecutive quarters indicate non-detectable levels of the compounds of interest.

3.1.2 SHALLOW SOIL SAMPLING

3.1.2.1 Objective and Scope

Additional soil sampling is proposed within the western portion of the site to further refine the site characterization. It is anticipated that seven borings will be completed on the western portion of the site using a combination of hand augering and mechanical drilling techniques. The supplemental soil sampling program will include sampling of the drainage ditch (four borings) that runs north-south through the western portion of the site and the storm water retention basin (three borings) in the northwestern portion of the site.

Drainage Ditch: Four soil borings are planned along the alignment of the drainage ditch that runs north-south in the western portion of the site. The proposed boring locations are shown on Figure 2. The borings will be advanced using a stainless steel bucket auger to a depth of approximately 6 feet. Auger cuttings from each 18-inch interval will be composited for chemical analysis. Xylene samples will be collected from each interval prior to compositing the remaining sample. Each composite sample over the entire 6-foot interval will be submitted for chemical analysis of the parameters listed in "revised" Table 2.

Containment Basin: Three soil borings are planned within the floor of the existing containment basin. Boring locations will be selected in the field with the aid of a random number table. Dimensions of the basin will be

measured in the X and Y direction using the southwestern corner of the basin as the point of origin. The dimensions will then be multiplied by the respective random numbers and the borings field located.

The three borings will be advanced using a stainless steel bucket auger to a depth of approximately 6 feet. Auger cuttings will be composited in 18-inch intervals over the entire depth of the boring. All samples collected will be submitted to the analytical laboratory for chemical analysis. Samples will be analyzed for the parameters listed in "revised" Table 2. Xylene samples will be collected from each interval prior to compositing the remaining sample.

Western Portion of Site: All unpaved areas in the western portion of the site will receive a low permeability surface cap as part of the planned long-term remedial responses (refer to Section 7.0). The approximate area to be capped is shown in Figure 3. Except as noted above, no additional soil sampling within the western portion of the site is planned at this time.

Soil Stockpile Area: Sampling of the soil stockpile located west of building 'D' was conducted in 1987 and revealed varying concentrations of the pesticides of concern and arsenic. No additional sampling of the stockpile area is planned at this time. The stockpile area is the site of a proposed new containment basin that is currently under design (refer to Figure 3). Construction of the basin is expected to require excavation and disposal (at a regulated landfill) of portions of the stockpile and underlying soil. A sampling plan will be part of the design documents for the new basin. The sampling plan will provide for documentation of the contaminant concentrations of the materials left in place. Any contaminated areas of the stockpile not removed during construction of the new containment basin will receive a surface cap.

3.1.2.2 Technical Approach

Procedures for soil sampling along with associated documentation and decontamination procedures will be consistent with the Sampling Plan and QA/QC Plan included as Appendices 3 and 4 of the original Work Plan. Mechanical drilling equipment will be utilized where access with a drilling rig is attainable. In areas where a drilling rig cannot be mobilized hand augering techniques will be employed.

ENSECO, Incorporated (Rocky Mountain Analytical Laboratory) will be utilized to provide analytical services during the supplemental field investigation. A copy of ENSECO's quality assurance program plan for environmental chemical monitoring is provided as Attachment 1.

3.1.3 AMBIENT AIR SAMPLING

Ambient air sampling was not included in the scope of work described in the Work Plan dated June 26, 1987. However, USEPA has expressed concern about potential health risks associated with exposure to airborne dust that may include the pesticides of concern and arsenic. To address these concerns and provide data for the endangerment assessment, an ambient air sampling program is planned as part of the supplemental field activities.

The ambient air samples will be collected in the fall months of 1988 using high-volume sampling techniques. Two sampling events are planned. The sampling events will be spaced as weather permits to reflect prevailing wind directions. Each of the sampling events will include one upwind and three downwind sampling stations. Sample stations will be selected based on the anticipated prevailing wind patterns and site conditions. All sample locations will be established near the perimeter of the facility in a portion of the site dictated by short-term weather forecasts. A wind

rose for Lambert Air Field, presented as Figure 4, will be used to establish prevailing wind directions. Short-term local forecasts will be utilized to select the final sampling locations within 24 hours of the scheduled sampling event. There is no criteria on wind direction or the minimum wind velocity for a sample to be acceptable.

Attempts will be made to collect all air samples during periods with no precipitation. If one-quarter inch or less of rain falls in the first 15 hours of the 24-hour sampling event, the air samples will be considered acceptable.

The ambient air sample stations will use high-volume samplers powered by electricity from an outlet or generator. The samplers will be equipped with the necessary hardware to collect total particulates and potential pesticide vapors associated with the particulate fraction. Total particulates will consist of ambient air particulates larger than 0.3 microns. The particulate fractions will be collected on a quartz fiber filter while the vapor fractions will be absorbed to a polyurethane foam (PUF) cartridge. Samples collected will be analyzed for the parameters listed in Table 3.

In addition, one sample station will be paired with a General Metal Works PM-10 type sampler or its equivalent. This sampler will collect particulates from 0.3 microns to approximately 10 microns. The information will be used to evaluate the respirable particulate fraction for input into the endangerment assessments.

A meteorological station will be established during the collection events to monitor wind direction and wind speed. The weather station at Lambert Air Field will be used to document barometric pressure, temperature, and rainfall.

The following outlines the general procedures that will be used to collect ambient air samples. All samples will be collected in accordance with EPA method TO4 (see Attachment 2).

A. Set-up the high-volume samplers at the designated locations in an unobstructed area at least 2 meters from any obstacle to air flow. If a generator is used, place the generator a minimum of 24 feet downwind of the samplers.

B. Conduct a calibration check on the sampler according to established manufacturer instructions.

C. Place a clean sampling module with a quartz fiber filter and PUF cartridge into the sampler using forceps and latex gloves.

D. Check the zero reading on the Magnehelic gauge. Record the ambient temperature, barometric pressure, elapsed time meter setting, sampler serial number, filter number, and glass fiber filter lot number in the field logbook.

E. Turn on the power switch, activate the elapsed time meter, and record the start time. Adjust the flow rate, if necessary, using the flow control valve.

F. Check and record the flow rate every 6 hours. Record the ambient temperature and barometric pressure concurrently.

G. At the end of the sampling period, turn off the power and record the end time. Remove the particulate filter and PUF cartridge and wrap them in aluminum foil. Place the samples in sealed, inert, labeled containers for transport to laboratory at 20°C.

H. Complete the sample collection field sheet and chain-of-custody forms.

3.2 OFF-SITE ACTIVITIES

The supplemental field investigation will include additional shallow soil sampling in the locations proposed on Figure 2. In addition, off-site field activities will include the installation of three additional ground water monitoring wells, initial and confirmation sampling of these wells, and sampling these wells at times corresponding with the quarterly ground water sampling.

It is noted that installation of the off-site wells and off-site soil sampling requires access to adjoining properties. If property access should become a problem and substantially delay scheduled field activities, USEPA will be notified immediately and a revised schedule will be discussed.

3.2.1 OFF-SITE WELL SURVEY

The off-site well survey originally conducted in 1981 and 1984 (and described in Section 3.2.1 of the Original Work Plan) will be updated. The update will include a review of all pertinent records on file with the Missouri Department of Natural Resources (MDNR). An attempt will be made to field locate (verify) any wells identified as a result of the records search that had not been previously identified.

3.2.2 DRILLING AND WELL INSTALLATION

3.2.2.2 Locations

The approximate locations of the three off-site well locations are shown in "revised" Figure 5. The two wells, identified as OWC-26 and OWC-27, will be screened in the upper limestone. The well identified as OWC-28 will be screened in the overburden.

3.2.2.3 Technical Approach

Drilling procedures, sampling procedures, documentation, and decontamination for the three proposed off-site wells will be consistent with those described in Section 3.2.2 of the original Work Plan and the Sampling Plan.

Slug tests will be conducted in OWC-24, OWC-25, OWC-26, OWC-27 and OWC-28 as part of the supplemental field investigation to evaluate the effectiveness of the wells and to aid in hydrologic characterization of the site.

3.2.3 GROUND WATER SAMPLING

OWC-26, OWC-27, and OWC-28 will be sampled within one week after completion of installation and development. A verification sampling and analysis event will be performed approximately two (2) weeks after the initial sampling of these wells. The proposed off-site wells will then be included in the quarterly ground water monitoring network. Parameters for ground water analysis of the off-site wells are listed in Table 1a.

3.2.4 SHALLOW SOIL SAMPLING

The 1987 soil sampling in the vicinity of the arsenic off-loading area (refer to Figure 2) showed arsenic and pesticide contamination in the soil samples obtained. To better define the horizontal and vertical distribution of contaminants in this area, it is anticipated that the supplemental field investigation will include 19 soil borings within the unpaved area immediately north of the site property. The proposed boring locations are shown in Figure 2. Additionally, five borings are planned along the alignment of a drainage ditch that flows from west to east along the north property line. These proposed borings are shown in Figure 2 but may be relocated in the field. Any decision to relocate these borings will be based on communications between the WCC field manager and Chevron Chemical Company.

The off-site borings will be drilled with a truck-mounted drill rig where access permission can be obtained and the boring locations are accessible to the equipment. Drilling and sampling procedures will be consistent with the previous borings in this area, except the sample intervals will be 0 to 0.5 feet, 0.5 to 2 feet, 2 to 4 feet, and 4 to 6 feet. Where truck access is not feasible, the borings will be advanced using hand augering techniques. Auger cuttings will be collected from the depth intervals described above for chemical analysis.

Samples from the 0 to 0.5 feet and the 0.5 to 2 feet depth intervals will be submitted for chemical analysis of the parameters listed in "revised" Table 4. The remaining samples will be archived at the facility in a restricted access freezer at or below 4°C. Following review of the initial analytical results, selected archived samples may be submitted for chemical analysis.

4.0 DATA MANAGEMENT

4.1 LABORATORY TESTING

All analytical testing on soil and ground water samples will be conducted by ENSECO, Incorporated (Rocky Mountain Analytical Laboratory).

All analyses will be performed in accordance with standard USEPA methods as detailed in the approved Quality Assurance/Quality Control (QA/QC) Plan (Appendix 4 to the June 26, 1987 Work Plan).

As part of the laboratory program, at least five of the initial soil samples analyzed during the field investigation will be returned from the laboratory to the field archive. These samples will serve as control samples. It is intended that these five samples will have a range of contaminant concentrations. At such time when any archived samples are submitted to the laboratory for analyses, the previously analyzed control samples will be returned to the laboratory and re-analyzed. Comparisons

will be made between the two sets of analytical results from the control samples to determine the percent degradation, if any, and, thus, provide confirmation of the validity of the archived samples. In order that sufficient sample volume remains to return the material to field archives, approximately two times the necessary sample volume will be collected at five randomly selected locations.

5.0 INTERIM POTENTIAL MITIGATION MEASURES

The Work Plan dated June 26, 1988 provides for an assessment of interim potential mitigation measures including targeted removals, surface water infiltration controls and ground water pumping and treatment. As shown on Figure 1, the revised Work Plan schedule also includes implementation of certain long-term remedial responses (refer to Section 7.0). During the endangerment assessment, a review of interim responses will be made to evaluate whether short-term measures are necessary to reduce the potential for human exposure and environmental migration of contaminants via direct contact with soil, airborne dust, and surface water in the off-site area north of the site. A report containing proposed interim responses for the off-site area adjacent to the facility is expected to be submitted to USEPA for review approximately two months after completion of the supplemental field investigation.

6.0 ENDANGERMENT ASSESSMENT

Task 9 of the project schedule shown in Figure 1 provides for an endangerment assessment (EA) of the site based on existing data and data obtained from the supplemental field investigation. The EA is expected to be submitted to USEPA for review approximately four months after completion of the supplemental site investigation. The findings of the EA will be utilized in developing the response action plan (RAP) for the facility. The focus of the EA and RAP will be ground water and off-site soil contamination. The following amendments replace Section 6.0 of the original Work Plan.

The "endangerment assessment" (baseline public health evaluation) will be conducted in accordance with the Superfund Public Health Evaluation Manual (USEPA 504/1-86/060, October 1986) and other relevant guidance documents. The evaluation is a sequential procedure wherein an estimate can be made that a threatened or actual release of a potentially hazardous substance does or does not pose danger to public health, welfare, or the environment.

The EA evaluates the collective demographic and geographic data of the site integrated with physico-chemical data, chemical exposure information, and biological effects of the substances of concern to estimate the significance of risks.

The ultimate goal of this EA is to assess any potential risks posed by the substances of concern and ultimately to provide guidelines for establishing cleanup criteria for contaminated soil and ground water if any cleanup is required.

The EA process which will be followed utilizes the following five components:

- Indicator Chemical Identification;
- Exposure Assessment;
- Toxicity Assessment;
- Risk Characterization; and
- Uncertainty Analysis.

6.1 INDICATOR CHEMICAL IDENTIFICATION

All compounds of concern will be evaluated during the indicator chemical selection process as described by the Superfund Public Health Environmental Manual (SPHEM). Compounds to be included in the indicator chemical selection process will include:

- aldrin,
- dieldrin,
- lindane,

- 4,4'-DDT,
- 4,4'-DDE,
- 4,4'-DDD,
- chlordane,
- heptachlor,
- toxaphene,
- endrin,
- methoxychlor,
- 2,4-D,
- 2,4,5-T,
- Maneb,
- xylene, and
- arsenic.

Chemicals representative of the potential hazards posed by the site will be selected based on the results of the indicator chemical selection process to be carried through the remainder of the Endangerment Assessment.

6.2 EXPOSURE ASSESSMENT

This component identifies the actual or potential routes of exposure. This step also involves characterizing the exposed populations and estimating the actual or potential extent of exposure. The exposure assessment process will consist of the following basic steps.

6.2.1 IDENTIFICATION OF EXPOSURE PATHWAYS AND EXPOSED POPULATIONS

In this step, possible release sources, media, and human exposure points are identified. In addition, population subgroups, which may represent special risk groups, are identified.

6.2.2 QUANTIFICATION OF CHEMICAL RELEASE

This step evaluates and calculates release rates from various media such as air and soil as they relate specifically at the study area.

6.2.3 EVALUATION OF ENVIRONMENTAL FATE

The behavior of the substances of concern in the environment will be evaluated in this step. This information will be evaluated relevant to its impact on human exposure.

6.2.4 ESTIMATION OF CHEMICAL INTAKE

Based on sampling data information, estimates will be calculated for contaminant intake by various routes of exposure such as oral ingestion, inhalation, and skin absorption. These estimates will utilize factors which take into account bioavailability data which will allow scientific calculation of bio-uptake of the compounds. Published reports on bio-uptake of chemicals will be reviewed to obtain this information.

6.2.5 COMPARISON TO REQUIREMENTS, STANDARDS, AND CRITERIA

An evaluation of cleanup criteria will be made with respect to the compounds of concern, the exposure pathway, and applicable and relevant and appropriate standards.

6.3 TOXICITY ASSESSMENT

This component involves an evaluation of the nature and extent of health hazards associated with exposure to the substances of concern. The objectives of this assessment are to present critical toxicity values for non-carcinogenic (acceptable intakes for subchronic and chronic exposure) and carcinogenic effects (potency factors). A general discussion of acute, chronic, reproductive, genotoxic, and other effects will also be developed to allow for a more complete evaluation of potential health effects.

6.4 RISK CHARACTERIZATION

This is the step in the baseline endangerment assessment process in which comparisons are made between projected intakes and reference levels for non-carcinogens (i.e. allowable daily intakes) and between calculated risks and target risks for potential carcinogens.

A hazard index for non-carcinogenic effects will be calculated according to the equation given below:

$$\text{Hazard Index} = E/RL + E_2/RL_2 + \ldots E_i/RL_i$$

where E_i = Exposure level (or intake) for the i^{th} toxicant

RL_i = Reference level (or intake) for the i^{th} toxicant.

This assumes that multiple subthreshold exposures could result in an adverse effect and that the magnitude or the adverse effect will be proportional to the sum of the ratios of the subthreshold exposures to acceptable exposures.

Potential carcinogenic risks will be calculated using the following equations:

Carcinogenic Risk = [CDI (route of exposure) X Carcinogen Potency Factor (route of exposure)]

(Where potency factors are known.)

These values then represent the risks or hazards presented by the site as a "baseline" evaluation.

6.5 UNCERTAINTY ANALYSIS

As with many processes in the scientific area, risk assessments are based on best estimates. There are a number of uncertainties inherent in this process. Therefore, an uncertainty analysis will be conducted in accordance with the guidance document to minimize the effect of any biases which may have been incidentally introduced into the effect of extrapolation of toxicity data from animals to humans, extrapolation of toxicity data from high dose to low does, and completeness of site characterization.

7.0 EVALUATION AND NEED FOR IMPLEMENTATION OF POTENTIAL REMEDIAL RESPONSES

The provisions of Section 7.0 of the June 26, 1987 Work Plan remain appropriate excluding Section 7.4. Section 7.4 describes an Alternate Concentration Limit (ACL) demonstration which was initially considered as an approach to arrive at acceptable levels for clean up at the site. However, the new CERCLA ACL policy includes major restrictions on how USEPA can utilize the health-protective ACLs. Consequently, the ACL demonstration included in Section 7.4 is deleted from further consideration.

Chevron plans to proceed with implementation of certain long-term remedial responses following USEPA approval of the Work Plan amendments. These responses are described below:

Surface Water Run-on Controls: At present, an open ditch oriented north/south carries surface water run-on across the western portion of the site. The open ditch discharges into a 30-inch culvert located west of the existing containment basin. The culvert flows underground to the north on the property north of the Chevron facility. To reduce surface water infiltration across the site and possible migration of contaminants, the open ditch will be replaced with a subsurface storm sewer. The new storm sewer will be located near the alignment of the existing ditch and designed to discharge into the existing sewer, refer to Figure 3. The depth of excavation required to establish the design flow line is expected to be nominal. Any excavated materials will be used as backfill or disposed of off-site as hazardous waste. Design studies for the sewer will include a topographic survey of the sewer alignment and preparation of plans and specifications. As shown in Figure 1, construction of the sewer is scheduled for 1989.

Surface Water Infiltration Controls: The majority of the site is covered by buildings or pavements except for the western portion of the site. To further reduce surface water infiltration in the western portion of the site, this area will be capped with low permeability materials such as clay, reinforced concrete, asphaltic concrete, or a combination thereof. The approximate area to be capped is shown on Figure 3. Design studies for the surface cap will include a topographic survey and preparation of design plans and specifications. As shown in Figure 1, construction of the surface cap is scheduled for 1989.

Prior to initiating the the installation of the proposed low permeability cap, Chevron will submit a cap design to EPA for review and approval. Included with the propsed cap design will be a contingency plan addressing the potential need for additional soil sampling and/or remediation, if necessary, should the cap be altered due to construction or demolition.

Containment Basin: The existing containment basin will be replaced with a larger basin designed to minimize seepage losses from the basin (refer to Figure 3). The basin will be used for temporary storage of surface water runoff and fire water in the event of an on-site fire. All excavated materials will be disposed of as hazardous waste.

It is anticipated that the initial construction activities described above will consist of sewer construction followed by surface capping the western portion of the site excluding the new containment basin. The new basin

will be constructed prior to decommissioning of the existing basin. In the latter stages of the site improvements, the area of the old basin and any unpaved areas surrounding the new basin will be capped.

The evaluation and need for implementation of additional remedial response will be based on the findings of the endangerment assessment. Certain interim responses for the off-site areas of soil contamination (i.e. access restrictions, placement of a geosynthetic cover to reduce wind blown contamination) will be reviewed and implemented, if necessary, when the results of the EA are available. The evaluation of long-term remedial responses for ground water and off-site soil contamination will be summarized in a Draft Response Action Plan to be submitted to USEPA for review approximately eight months (refer to Figure 1) after completion of the supplemental field investigation.

8.0 SCHEDULE

The schedule presented in Figure 10 of the original Work Plan is replaced by "revised" Figure 1 in this document.

REVISED
TABLE 1

PARAMETERS FOR CHEMICAL ANALYSIS OF SEMI-ANNUAL GROUND WATER SAMPLES COLLECTED FROM THE ON-SITE MONITORING WELLS CURRENTLY SAMPLED

Pesticides (Herbicides)	Pesticides (Insecticides)	Volatile Organics	Metals
2,4-D	Aldrin	Xylol	Dissolved Arsenic
2,4,5-T	Dieldrin		Total Arsenic
	Lindane		
	4,4-DDT		
	4,4-DDD		
	4,4-DDE		

NOTE: On-site wells to be monitored semi-annually include: OWC-1, OWC-12A, OWC-14, OWC-15, OWC-16, OWC-17, OWC-18, OWC-19, and OWC-20.

TABLE 1a

PARAMETERS FOR CHEMICAL ANALYSIS OF QUARTERLY
GROUND WATER SAMPLES COLLECTED FROM
OWC-24, OWC-25, OWC-26, OWC-27 AND OWC-28

Pesticides (Herbicides)	Pesticides (Insecticides)	Volatile Organics	Metals
2,4-D	Aldrin	Xylol	Dissolved Arsenic
2,4,5-T	Dieldrin		Total Arsenic
	Lindane		
	Chlordane		
	Heptachlor		
	Endrin		
	Methoxychlor		
	Toxaphene		
	4,4-DDT		
	4,4-DDD		
	4,4-DDE		

REVISED
TABLE 2

PARAMETERS FOR CHEMICAL ANALYSIS OF SOIL SAMPLES
FROM ON-SITE DRAINAGE DITCH/CONTAINMENT BASIN

Pesticides (Herbicides)	Pesticides (Insecticides)	Pesticides (Fungicides)	Metals	Volatile Organics
2,4-D	Aldrin	Maneb	Arsenic	Xylene
2,4,5-T	Dieldrin			
	4,4'-DDT			
	4,4'-DDE			
	4,4'-DDD			
	Chlordane			
	Heptachlor			
	Lindane			

NOTE: 1. Certain compounds have been deleted from the compound list because of the 1987 sampling results. Toxaphene, endrin, methoxychlor, and ethylene thiourea were not detected in any of the 1987 soil samples and will not be included in the chemical analyses during the supplemental field investigation.

TABLE 3

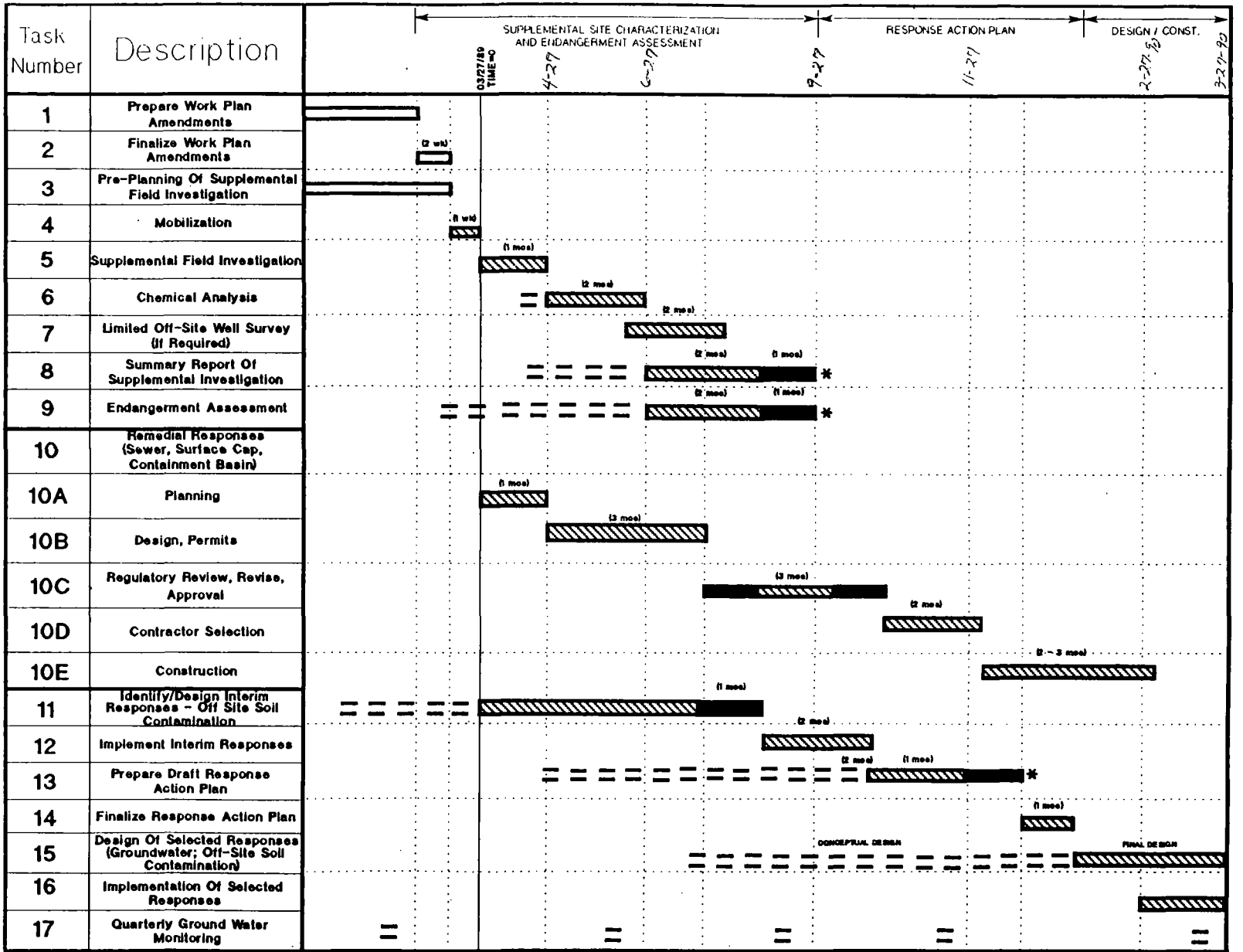
PARAMETERS FOR CHEMICAL ANALYSIS OF AIR FILTERS/CARTRIDGES

Pesticides (Insecticides)	Metals
Aldrin	Arsenic
Dieldrin	
Lindane	
4,4-DDT	
4,4-DDE	
4,4-DDD	
Chlordane	
Heptachlor	

REVISED
TABLE 4

PARAMETERS FOR CHEMICAL ANALYSIS OF SOIL SAMPLES
FROM OFF-SITE SOIL BORINGS

Pesticides (Insecticides)	Volatile Organics	Metals
4,4-DDT	Xylene	Arsenic
4,4-DDE		
4,4-DDD		
Aldrin		
Dieldrin		
Chlordane		
Heptachlor		
Lindane		



NOTES:

THIS SYMBOL DENOTES COMPLETED ACTIVITIES

THIS SYMBOL DENOTES THE PERIOD FOR EPA REVIEW. ADHERENCE TO THE PROPOSED SCHEDULE WILL BE DEPENDENT ON EPA REVIEW.

* THIS SYMBOL DENOTES PROJECT MEETING BETWEEN EPA AND CHEVRON. THE PROJECT SCHEDULE WILL BE UPDATED AND REVISED IF NECESSARY AFTER EACH MEETING.

START OF THE SUPPLEMENTAL FIELD INVESTIGATION IS CONTINGENT UPON WRITTEN APPROVAL OF THE WORK PLAN AMENDMENTS BY EPA.

ORTHO CHEVRON PLANT
MARYLAND HEIGHTS, MISSOURI

WOODWARD - CLYDE CONSULTANTS
ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS

REVISED WORK PLAN SCHEDULE

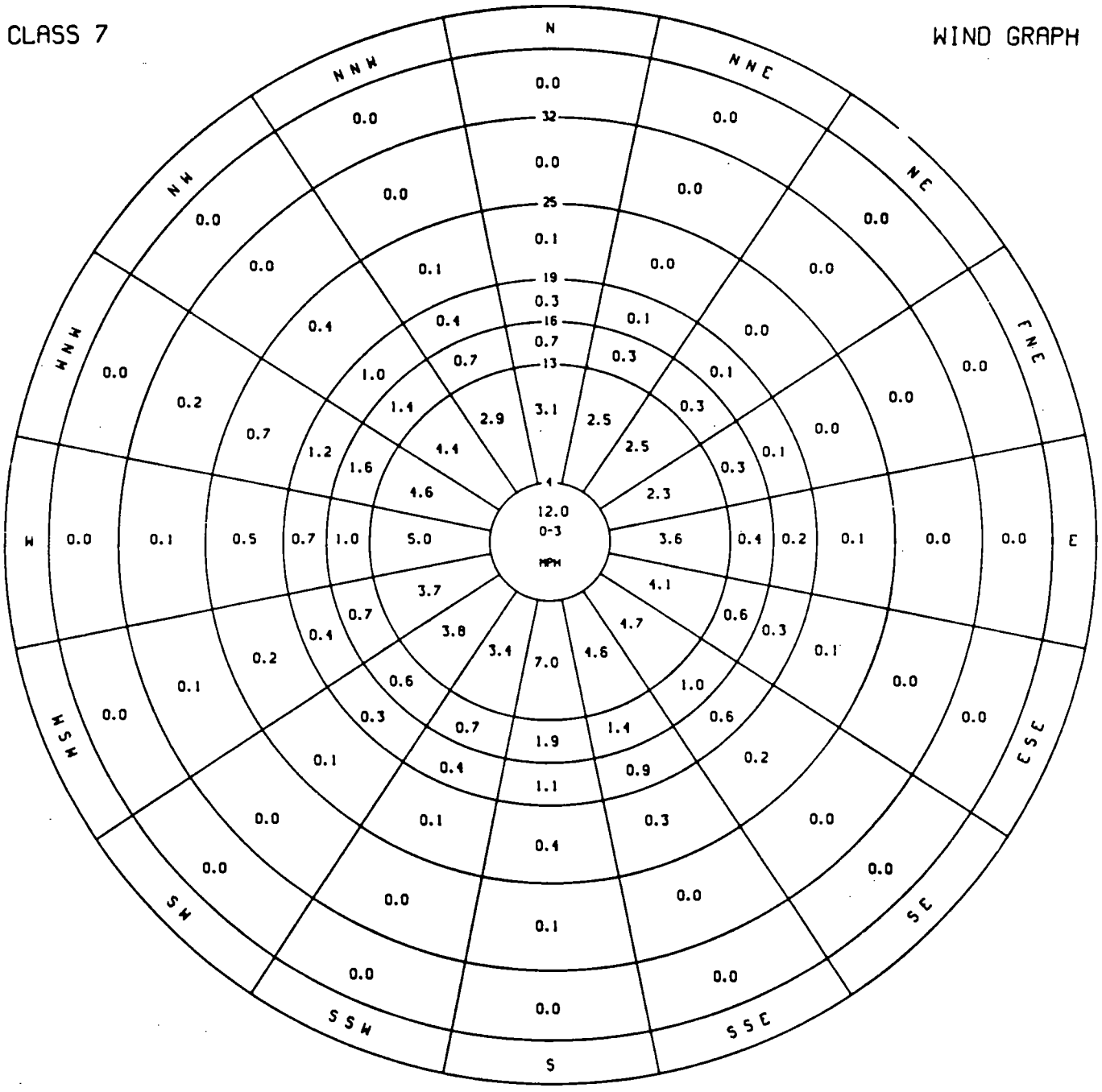
DRN BY	DATE	PROJECT NO.	REV.
KDC	03-03-89	13C114-21	1
CHK'D BY	DATE	FILE NAME	FIG.
DCC	03-03-89	ORTHOR2.GAL	1

STL ST LOUIS, MO

CEILING-VISIBILITY

CLASS 7

WIND GRAPH



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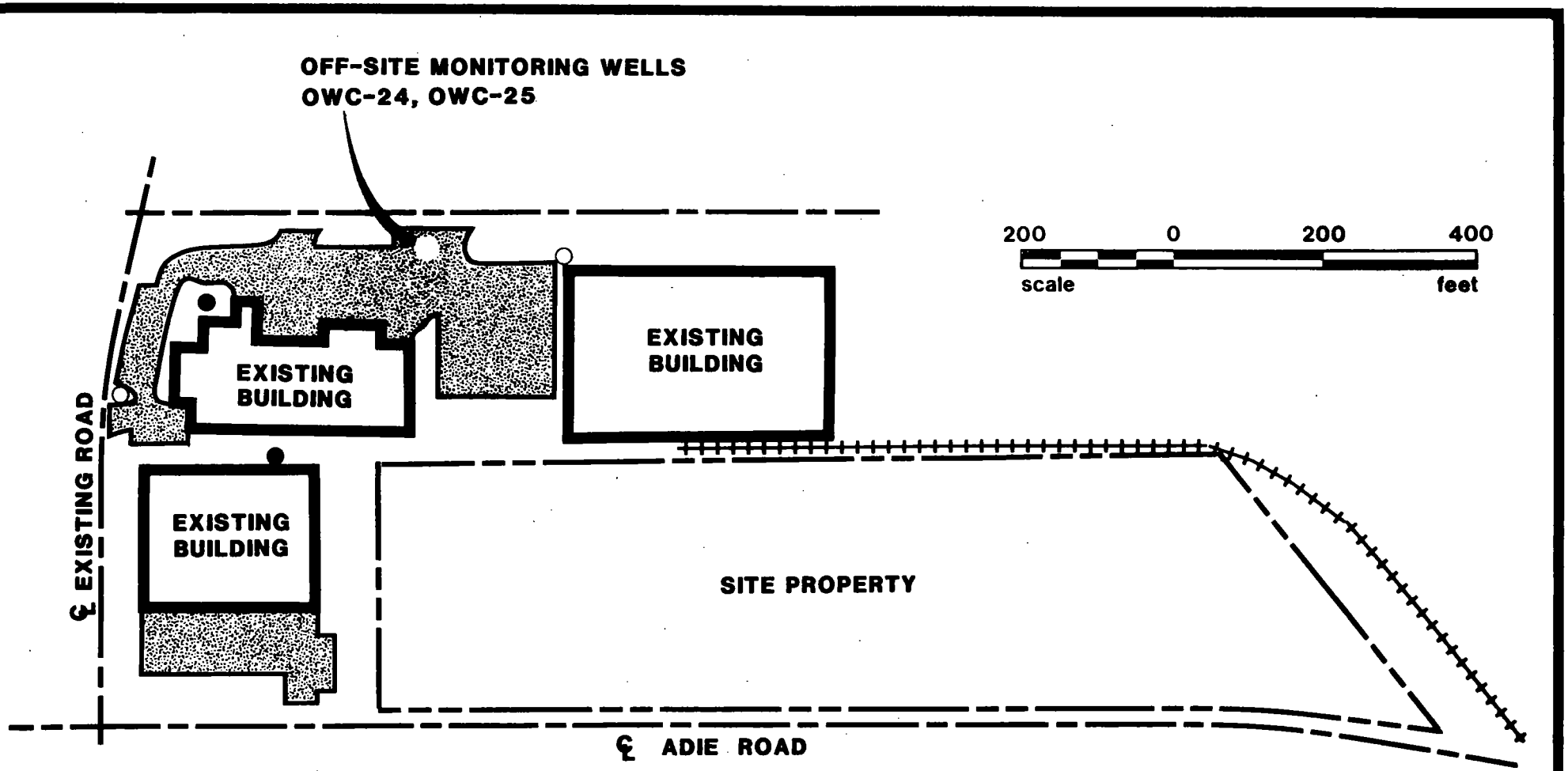
WIND ROSE
ST. LOUIS, MISSOURI AND SURROUNDING AREA

DRN. BY SDC	DATE 9/13/88	PROJECT NO. 13C114-19	FIG. NO. 4
CHK'D BY DCC	DATE 9/13/88		



LEGEND

- PAVED AREAS
- ● CANDIDATE WELL LOCATION
- ○ ALTERNATE WELL LOCATION

N

ORTHO CHEVRON PLANT
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ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS

PROPOSED MONITORING WELL LOCATIONS

DRN. BY SDC	DATE 8/23/88	PROJECT NO. 13C114-19	FIG. NO. 5
CHK'D BY WDS	DATE 8/23/88		

Appendix 1 - Data Not Previously Reported

There are no amendments to this appendix of the original Work Plan.

Appendix 2 - Health and Safety Plan

The currently approved Health and Safety Plan has been amended to require that all personnel involved with soil sampling in the vicinity of the Chevron facility wear dust masks. The majority of the site is either paved or vegetated, therefore, under normal working conditions only small amounts of dust would be generated. The use of dust masks will greatly reduce the potential for adverse health effects which may result from inhaling contaminated airborne dust. A copy of Amendment No. 1 to the Health and Safety Plan is included herein.

ADDENDUM 1
TO THE
HEALTH AND SAFETY PLAN
ORTHO-CHEVRON PLANT
MARYLAND HEIGHTS, MISSOURI
DATED
JUNE 1, 1987

INTRODUCTION

This is Addendum 1 to the Health and Safety Plan (HSP) for additional work to be conducted at the Ortho-Chevron Plant in Maryland Heights, Missouri. This Addendum modifies Section 5.0, Personnel Protection, of the original HSP dated June 1, 1987.

PURPOSE

The purpose of this Addendum is to modify the personnel protection requirements to protect on-site workers conducting soil sampling (or other intrusive activities) from potential hazards associated with wind blown dust.

During the July 1987 field investigation, the cyclodiene insecticides of concern were observed in the on-site soils at a maximum level of 959 mg/kg (chlordane). In general, however, surficial levels were less than 100 mg/kg. Although most areas of the site are paved or vegetated, additional health and safety precautions are being taken at this time to protect field personnel form the potential hazards associated with these levels of pesticides in soils.

MODIFICATION

Dust masks have been added to the list of equipment set forth below (originally given on page 13 of the June 1, 1987 HSP) to protect on-site workers involved in soils sampling activities from the potential hazards associated with the inhalation of contaminated airborne dust. The personnel protective equipment detailed below is generally equivalent to USEPA modified Level D protection.

The required equipment shall include:

- Tyvek coverall (drilling and soil sampling).
- PVC or Saran-coated Tyvek coverall (well development and sampling).
- Latex or vinyl surgical gloves.
- Nitrile or neoprene work gloves (taped at wrist).
- Neoprene or PVC work boot (protective booties may by used for activities not associated with a drilling rig).
- Hard hat (for activities associated with a drilling rig).
- Goggles or safety glasses.
- Dust mask

During soil sampling activities, the dust masks shall be changed at least daily or if visible dust buildup is noted on the mask. Masks shall be disposed in a dumpster on-site.

ADDITIONAL HEALTH AND SAFETY REQUIREMENTS

All other health and safety requirements as set forth in the June 1, 1987, HSP shall remain in effect.

APPROVALS

Wayne D Smith

Wayne Smith
WCC Project Manager

Carla J. Dods 1-19-89

Carla J. Dods
Midwest Business Unit Health and Safety Officer

Martin E. Kemplin / cp

Martin E. Kemplin
WCC Eastern Operating Group
Corporate Health and Safety Officer

Appendix 3 - Sampling Plan

The scope of work for the supplemental field investigation is described in previous sections of this document. The basic provisions of the sampling plan except as amended by this document remain in effect for future drilling and sampling activities at the site. Future work will also be consistent with clarifications to the sampling plan provided in Chevron's letter to USEPA dated February 8, 1988. A copy of that letter is provided in Attachment 3 for reference.

Appendix 4 - QA/QC Plan

The provisions of the QA/QC plan presented in the June 26, 1987 Work Plan remain in effect except as amended by this document. In particular, the parameters for ground water and soil sample analyses are amended by Tables included in this document. ENSECO, Incorporated (Rocky Mountain Analytical Laboratories) will be utilized to provide all analytical services. A copy of their quality Assurance Program Plan For Environmental Chemical Monitoring is presented in Attachment 1 of this document.

ATTACHMENT 1

QUALITY ASSURANCE PROGRAM PLAN
FOR
ENVIRONMENTAL CHEMICAL MONITORING
ENSECO, INCORPORATED

ENSECO INCORPORATED
QUALITY ASSURANCE
PROGRAM PLAN
FOR
ENVIRONMENTAL CHEMICAL MONITORING

Prepared by:

Enseco Incorporated
4955 Yarrow Street
Arvada, CO 80002

Revision 3.2
June, 1988

Approval:

Kathleen Carlberg
Vice President
Quality Assurance

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1. INTRODUCTION

Enseco Incorporated (Enseco) is the largest and most experienced independent environmental testing laboratory in the United States. The environmental component of Enseco consists of the combined resources of Erco Laboratory (Erco) in Cambridge, Massachusetts; Enseco East in Somerset, New Jersey (scheduled to begin operation in July, 1988); Rocky Mountain Analytical Laboratory (RMAL) in Denver, Colorado; and California Analytical Laboratory (CAL) in Sacramento, California. Two Enseco facilities specializing in aquatic toxicology are located in Marblehead, Massachusetts and Houston, Texas.

Enseco is committed to providing quality environmental analytical services. To ensure the production of scientifically sound, legally defensible data of known and proven quality, an extensive Quality Assurance (QA) program has been developed within Enseco. This program is closely monitored at both the Corporate and Divisional levels and relies on clearly defined objectives, well-documented procedures, a comprehensive audit system, and management support for its effectiveness.

2. DEFINITION, PURPOSE, AND SCOPE

Definition of Terms

Quality Assurance (QA): the total integrated program for assuring the reliability of data generated in the laboratory.

Quality Control (QC): the routine application of specific, well-documented procedures to ensure the generation of data of known and accepted quality, thus fulfilling the objectives of the QA program.

Quality Assurance Program Plan: an assemblage of management policies, objectives, principles, and general procedures outlining the techniques by which the laboratory produces data of known and accepted quality.

Standard Operating Procedure (SOP): a detailed, written description of a procedure designed to systematize and standardize the performance of the procedure.

Quality Control Manual: an assemblage of detailed SOP's describing the laboratory implementation of the QA Program Plan.

Quality Assurance Project Plan (QAPP): an assemblage of detailed SOP's describing how the laboratory will generate data that meet the data quality objective of a specific project.

Purpose of Document

The Enseco QA Program Plan presents an overview of the essential elements of our QA program. Enseco has modeled this plan along EPA guidelines as outlined in "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans," Office of Monitoring Systems and Quality Assurance, Office of Research and Development, U.S. Environmental Protection Agency (U.S. EPA), EPA-600/4-83-004, February, 1983.

Scope

This QA Program Plan is designed to control and monitor the quality of data generated in the Enseco laboratories. The described QA program is geared toward generating data that comply with federal regulatory requirements specified under the Clean Water Act (CWA), the Safe Drinking Water Act (SDWA), the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and their amendments (WQA, SARA, etc.) and state equivalents. Although the QC requirements of these various programs are not completely consistent, each of the programs base data quality judgments on three types of information:

- Data that indicate the overall qualifications of the laboratory to perform environmental analyses;
- Data that measure the laboratory's daily performance using a specific method; and
- Data that measure the effect of a specific matrix on the performance of a method.

The operational elements that are involved in making each of these assessments are described in Table 2-1 along with the pertinent section number from this document in which each is discussed.

Table 2-1

DATA QUALITY ASSESSMENT

Evaluation Criteria	Operational Elements	Section of QA Plan
LABORATORY QUALIFICATIONS	Facilities/equipment/staff.....	*
	Written SOP's for all laboratory procedures, including:.....	15
	Sample custody.....	5
	Calibration procedures.....	6
	Analysis procedures.....	7
	Data validation.....	8
	Documented QA program.....	1-15
	Laboratory certifications.....	10
LABORATORY PERFORMANCE	Check samples.....	9
	Reagent blanks.....	9
	Calibration data.....	6
	Method detection limits (determined on reagent blank).....	12
MATRIX EFFECTS	Matrix spike/matrix duplicate/ matrix spike duplicate analyses.....	9
	Sample surrogate recoveries.....	9
	Standard additions.....	9
	Field blanks.....	9
	Method detection limits (determined with specific sample matrix).....	12

* Described in a separate document available from Enseco.

3. RESPONSIBILITIES AND AUTHORITIES

Executing an effective QA program in a large and complex multi-laboratory system demands the commitment and attention of both management and staff. The QA effort at Enseco is managed by the QA office which reports directly to the Chief Executive Officer (CEO) and has the responsibility of overseeing and regulating all laboratory functions (see Figure 3-1). The QA office operates independently of all areas, generating analytical data to ensure complete objectivity in the evaluation of laboratory operations.

The QA Office is managed by an Enseco Vice President (VP) whose sole responsibility is to direct the Enseco QA program. The implementation of the QA program within each individual laboratory is the responsibility of the Divisional QA Director. The QA Director reports to both the VP of QA and to the Divisional Director, who manages the laboratory. In addition, all scientists within the organization play a vital role in assuring the quality of our work. We believe that the success of Enseco is dependent upon the continued commitment of all within the organization to a strong and viable QA Program. The responsibilities and levels of authority within the organization are described below.

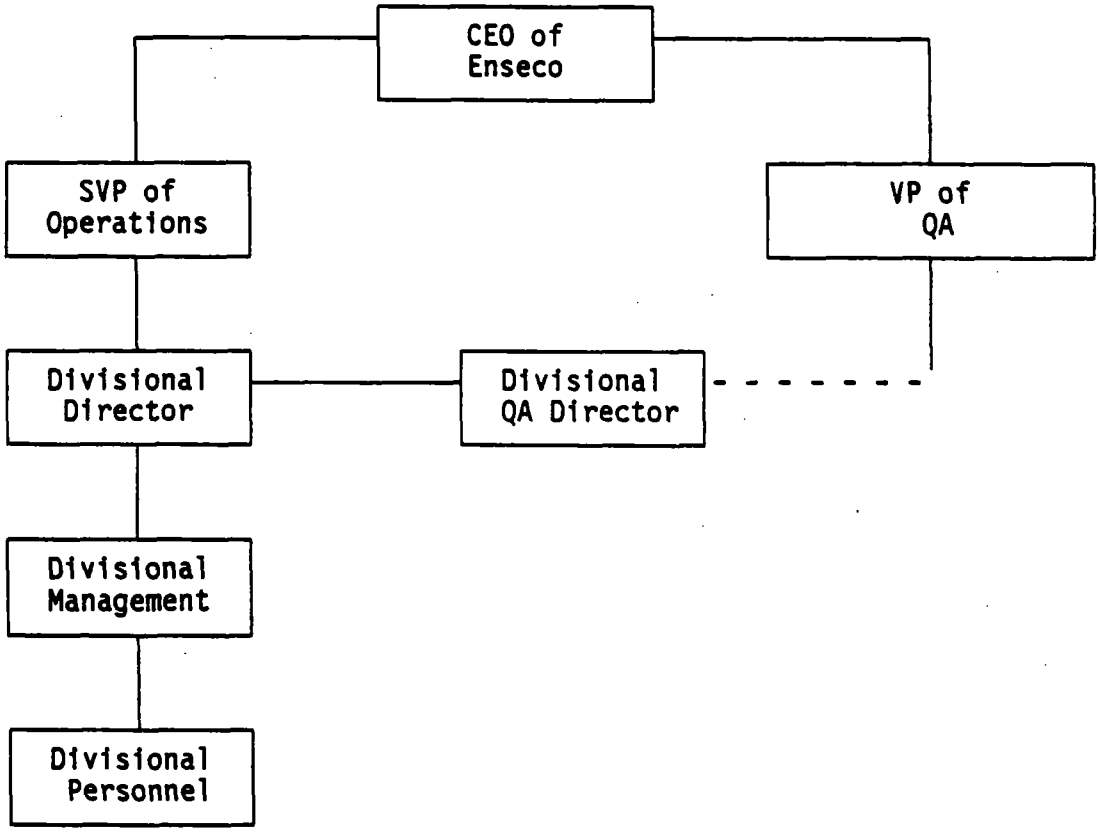
Corporate Quality Assurance Office

Members

The QA effort within Enseco is directed by the Corporate VP of QA who reports directly to the CEO of Enseco. The Corporate QA office also includes QA specialists who assist the VP in carrying out the responsibilities of the department.

Figure 3-1

ENSECO QA ORGANIZATIONAL CHART



Responsibilities

The VP of QA is responsible for:

- Developing and implementing a Corporate QA program that ensures that all data generated in Enseco laboratories are scientifically sound, legally defensible, and of known precision and accuracy;
- Monitoring the QA Plan to ensure compliance with QA objectives in all Enseco laboratories;
- Developing and implementing new QA procedures within the corporation to improve data quality;
- Conducting audits and inspections of all Enseco laboratories on a regular basis, reporting the results of those audits to management, and applying corrective actions as needed to ensure compliance with the Enseco QA Plan;
- Distributing Performance Evaluation (PE) samples to all Enseco laboratories on a routine basis, evaluating the results of those samples, reporting to management, and applying corrective actions as needed to ensure that all Enseco laboratories are able to generate data that meet the data quality objectives defined in the QA Plan;
- Establishing data bases that accurately reflect the performance of each of the Enseco laboratories;
- Maintaining copies of all SOP's;
- Directing Laboratory QA Directors in the implementation of the Enseco QA Plan within individual facilities;
- Chairing the Enseco QA Committee, a working committee which includes all of the Laboratory QA Directors and QA Specialists and deals with QA issues on an ongoing basis;
- Coordinating certification programs within Enseco;
- Conducting seminars on QA issues for both clients and laboratory staff; and
- Promoting sound QA practices within the environmental regulatory and analytical communities.

Authority

The VP of QA is the final authority on all issues dealing with data quality and has the authority to require that procedures be amended or discontinued, or analyses suspended or repeated. He also has the authority to suspend or terminate employees on the grounds of dishonesty, incompetence, or repeated non-compliance with QA procedures. In addition, the VP of QA has the authority to overrule decisions and actions of the Divisional QA Directors and must approve the termination or transfer of any Divisional QA Director. The authority of the VP of QA comes directly from the CEO of Enseco.

Divisional Quality Assurance Departments

Members

Each Divisional QA Department is managed by a Divisional QA Director. The QA Director reports directly to the Divisional Director and indirectly to the Corporate VP of QA. The QA Director is supported by a QA staff within the laboratory.

Responsibilities

The Divisional QA Director is responsible for:

- Implementing Enseco QA policies;
- Monitoring the QA Plan within the laboratory to ensure complete compliance with QA objectives;
- Conducting in-house audits to identify potential problems and ensuring compliance with written SOP's;
- Performing statistical analyses of QC data and establishing data bases that accurately reflect the performance of the laboratory;

- Prescribing and monitoring corrective actions;
- Serving as the in-house client representative on all project inquiries involving data quality issues;
- Monitoring the preparation and verification of analytical standards;
- Assisting chemists in the writing of SOP's;
- Reporting the status of the laboratory QA program to the Corporate VP of QA with formal and informal communications;
- Maintaining records and archives of all QA/QC data, PE results, audit comments, and customer inquiries concerning data quality;
- Distributing current SOP's to the laboratory staff;
- Monitoring laboratory performance in the areas of holding times, turn-around times, and meeting contractual obligations;
- Conducting seminars on QA issues for clients and laboratory staff;
- Preparing QA project plans when needed;
- Assisting the Corporate QA office in the writing of QA manuals and procedures;
- Serving as a member of the Enseco QA Committee; and
- Auditing subcontractors.

Authority

The Divisional QA Director is the final authority within each laboratory on all issues dealing with data quality. He has the authority to require that procedures be amended or discontinued or analyses suspended or repeated. He can make recommendations to the Division Director and the Corporate VP of QA regarding suspension or termination of employees for incompetence or non-compliance with QA procedures. The authority of the Divisional QA Director comes directly from the Corporate VP of QA.

Divisional Management

Members

The supervisors and managers who direct the analytical work at each laboratory are directly responsible for ensuring that all employees reporting to them are complying with the Enseco QA Plan.

Responsibilities

Laboratory management is responsible for:

- Actively supporting the implementation of the Enseco QA Plan within the laboratory;
- Maintaining accurate SOP's and enforcing their use in the laboratory;
- Maintaining a work environment that emphasizes the importance of data quality; and
- Providing management support to the Corporate and Divisional QA departments.

Authority

The managers and supervisors of the laboratory have the authority to accept or reject data based on well-defined QC criteria. In addition, managers and supervisors, with the approval of the QA department, can accept data that fall outside of normal QC limits if, in their judgment, there are technical reasons which warrant the acceptance of the data. These circumstances must be well documented and any need for corrective action identified by the incident must be defined and initiated. The authority of the laboratory management comes directly from the Corporate VP of Operations and the Divisional Director.

Divisional Personnel

Members

All laboratory personnel involved in the generation and reporting of data have a responsibility to understand and follow the Enseco QA Plan.

Responsibilities

Laboratory personnel are responsible for:

- Having a working knowledge of the Enseco QA Plan;
- Ensuring that all work is generated in compliance with the Enseco QA Plan;
- Performing all work according to written SOP's;
- Ensuring that all documentation related to their work is complete and accurate; and
- Providing management with immediate notification of quality problems.

Authority

Laboratory personnel have the authority to accept or reject data based on compliance with well-defined QC acceptance criteria. The acceptance of data that fall outside QC criteria must be approved by laboratory management. The authority of the laboratory personnel flows from the Division Director.

4. SAMPLING PROCEDURES

The generation of quality data begins with the collection of the sample, and therefore the integrity of the sample collection process is of concern to the laboratory. Samples must be collected in such a way that no foreign material is introduced into the sample and no material of interest escapes from the sample prior to analysis. To ensure sample integrity, the following must be considered:

- Samples must be collected in appropriate containers. In general, glass containers are used for organic parameters and polyethylene containers for inorganic/metal parameters;
- The sample containers must be properly cleaned to ensure that the sample is not contaminated during the collection process;
- Samples must be preserved appropriately to ensure that no material of interest is lost due to adsorption, chemical or biological degradation, or volatilization;
- Appropriate volumes of sample must be collected to ensure that the required detection limits can be met and quality control samples can be analyzed; and
- Samples must be properly shipped to the laboratory, in the appropriate time frame, to ensure that holding times for the analyses can be met.

Enseco can assist in the sample collection process by providing consultation and assistance to clients designing sampling programs and also by making available to the client the Enseco "Sample Safe™", a set of appropriate sample containers that are properly cleaned and preserved for use in sample collection.

The maximum holding times recommended by Enseco, appropriate containers and preservatives, and minimum sample volumes required for routine organic, metal and conventional parameters are given in Appendix I. The Enseco holding times are in general agreement with EPA recommended holding times, as stated in the Contract Laboratory Program (CLP), RCRA, and National Pollution Discharge Elimination System (NPDES) programs. Other holding times can be honored if special arrangements are made with the laboratory.

$$RSD = 100\ (s/\bar{X})$$

or

$$CV = 100\ (s/\bar{X})$$

where: RSD = relative standard deviation

CV = coefficient of variation

s = standard deviation

$\bar{X}$ = mean

In the case of duplicates, the RPD between the two samples may be used to estimate precision.

$$RPD = \frac{|D_1 - D_2|}{(D_1 + D_2)/2} \times 100$$

where: RPD = relative percent difference

D_1 = first sample value

D_2 = second sample value (duplicate)

Accuracy is a determination of how close the measurement is to the true value. Accuracy can be assessed using standard reference materials, LCS, or spiked environmental samples. Unless specified otherwise in special contracts, Enseco monitors accuracy by comparing LCS results with the control limits established at plus or minus three standard deviation units from the mean of historical LCS results.

The determination of the accuracy of a measurement requires a knowledge of the true or accepted value for the signal being measured. Accuracy may be calculated in terms of percent recovery as follows:

$$\text{Percent Recovery} = \frac{X}{T} \times 100$$

where: X = the observed value of measurement

T = "true" value

Representativeness is the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Analytical data should represent the sample analyzed regardless of the heterogeneity of the original sample matrix. Enseco strives to accommodate all sample matrices. Some samples may require analysis of multiple phases to obtain representative results.

Completeness is a measure of the amount of valid data obtained from a measurement system compared with the amount that was expected to be obtained under correct normal conditions.

To be considered complete, the data set must contain all QC check analyses verifying precision and accuracy for the analytical protocol. In addition, all data are reviewed in terms of stated goals in order to determine if the data base is sufficient.

When possible, the percent completeness for each set of samples is calculated as follows:

$$\text{Completeness} = \frac{\text{valid data obtained}}{\text{total data planned}} \times 100\%$$

Comparability expresses the confidence with which one data set can be compared to another data set measuring the same property. Comparability is ensured through the use of established and approved analytical methods, consistency in the basis of analysis (wet weight, volume, etc.), and consistency in reporting units (ppm, ppb, etc.).

Detection Limits

The sensitivity of an analytical method is related to the detection limit, (i.e., the lowest concentration of an analyte that can be detected at a specific confidence level). Definitions of Instrument Detection Limit (IDL), MDL, Limit of Quantitation (LOQ), and Practical Quantitation Limit (PQL) follow. The relationship of these terms is expressed graphically in Figure 12-1.

An IDL is the smallest signal above background noise that an instrument can detect at a 99% confidence level. An IDL is measured by analyzing replicate blank samples. It is calculated by the mean plus two standard deviations for a normal distribution, or three standard deviations for data which does not obey a normal distribution.

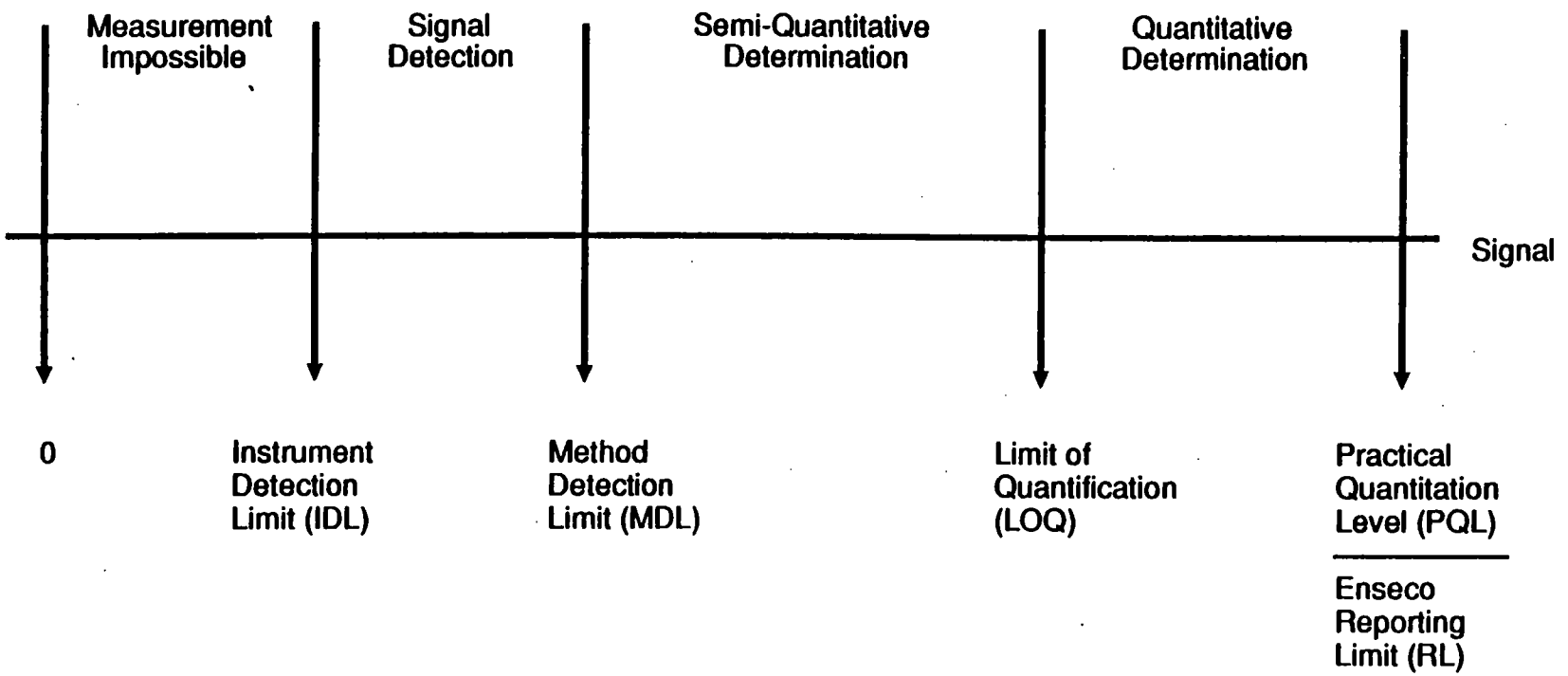
An MDL is the minimum signal level required to qualitatively identify a specific analyte by a specific procedure at a confidence level which is greater than 97%. An MDL is measured by analyzing a minimum of seven (7) replicates spiked at one (1) to five (5) times the expected method detection limit. It is calculated by the standard deviation times the the Student t-value at the desired confidence level.

An LOQ is the minimum signal level required to quantitate a specific analyte by a specific procedure at the desired confidence level (intralaboratory). An LOQ is measured by analyzing a minimum of seven (7) replicates spiked at one (1) to five (5) times the expected method detection limit. It is calculated by ten times the standard deviation obtained in the MDL study.

A PQL is the minimum level that can be reliably achieved by a method within specified limits of precision and accuracy. A PQL is measured by the analysis of check samples containing analytes at concentrations of one (1) to five (5) times the MDL. It is calculated by evaluation of interlaboratory check sample results to derive a PQL.

Figure 12-1

Graphical Representation of Detection Limits



NOTE: The spaces along the horizontal "signal" axis between the various analytical limits are not meant to indicate any relative or absolute signal values.

MDL, LOQ and PQL may be determined in a blank matrix or a specific sample matrix, depending on the objectives of the determination. Enseco determines the MDL for routine method using a blank matrix. MDL's are determined in a specific sample matrix when requested by the client as matrix specific QC (see Section 9).

13. CORRECTIVE ACTION

When errors, deficiencies, or out-of-control situations exist, the QA program provides systematic procedures, called "corrective actions," to resolve problems and restore proper functioning to the analytical system.

Laboratory personnel are alerted that corrective actions may be necessary if:

- QC data are outside the warning or acceptable windows for precision and accuracy;
- Blanks, LCS or SCS contain contaminants above acceptable levels;
- Undesirable trends are detected in spike recoveries or RPD between duplicates;
- There are unusual changes in detection limits;
- Deficiencies are detected by the QA department during internal or external audits or from the results of performance evaluation samples; or
- Inquiries concerning data quality are received from clients.

Corrective action procedures are often handled at the bench level by the analyst, who reviews the preparation or extraction procedure for possible errors, checks the instrument calibration, spike and calibration mixes, instrument sensitivity, and so on. If the problem persists or cannot be identified, the matter is referred to the laboratory supervisor, manager and/or QA department for further investigation. Once resolved, full documentation of the corrective action procedure is filed with the QA department. Corrective action documentation is routinely reviewed by the VP of QA.

14. QA REPORTS TO MANAGEMENT

The reporting system is a valuable tool for measuring the overall effectiveness of the QA program. It serves as an instrument for evaluating the program design, identifying problems and trends, and planning for future needs. Divisional QA Directors submit extensive monthly reports to the VP of QA and the Divisional Director. These reports include:

- The results of the monthly systems audit including any corrective actions taken;
- Performance evaluation scores and commentaries;
- Results of site visits and audits by regulatory agencies and clients;
- Performance on major contracts, (including CLP);
- Problems encountered and corrective actions taken;
- Holding time violations; and
- Comments and recommendations.

In addition, on a weekly basis, a summary of the 5% QA audit of reported data is sent to the Corporate QA Office.

The VP of QA submits weekly reports to the CEO and monthly report to the Enseco Management Committee and each Divisional Director. These reports summarize the information gathered through the laboratory reporting system and contain a thorough review and evaluation of laboratory operations throughout Enseco.

15. LABORATORY DOCUMENTATION

Complete and accurate documentation of analytical and procedural information is an important part of the QA program. The following describes different types of documentation used in the Enseco laboratories.

SOP's

Details of analytical and QC protocols are contained in SOP's. SOP's are documents that contain detailed information on the requirements for the correct performance of a laboratory procedure. Enseco has four categories of laboratory SOP's:

- SOP's for Performance of an Analytical Method;
- SOP's for Preparation of Standards and Reagents;
- SOP's for Equipment Operation, Calibration, and Maintenance; and
- SOP's for General Laboratory Procedures.

The formats for these SOP'S are shown in Figures 6 through 9.

All SOP'S are approved by the QA Department before being implemented. The distribution of current SOP'S and archiving of outdated ones is controlled through the QA Department by the Document Custodian.

LDMS

Enseco laboratories rely on a LDMS as the primary data base. Client information, sample results, and QC results are all stored in the LDMS. Reports are generated directly from the data base to eliminate transcription errors. A tiered security system is in place to control the

ability of lab personnel to make changes, and the system is designed with an audit trail that identifies when information has been changed and who changed it. The most recent two to three months of analytical data are kept on-line. All other data are archived on magnetic tape or optical disk.

Laboratory Bench Sheets

Laboratory bench sheets are used to document information from routine laboratory operations, including sample preparation and analysis. Bench sheets are used to ensure that the information is recorded in a complete and organized manner and that the analysis can be reconstructed, if necessary. Portions of information from the bench sheet are also stored in the LDMS.

Laboratory Notebooks

Laboratory notebooks are used to document information that cannot easily be recorded in the LDMS. Information typically recorded in laboratory notebooks includes unusual observations or occurrences in the analysis of samples, or methods development information. Each page in a laboratory notebook is initialed and dated as information is entered.

Project Files

A project file is created for each project handled within the laboratory. The project file contains all documents associated with the project. This includes correspondence from the client, chain-of-custody records, raw data, copies of laboratory notebook entries pertaining to the project, and a copy of the final report. When a project is complete, all records are passed to the Document Custodian who inventories the file, checks for completeness, and puts the file into document archive.

APPENDIX I

ENSECO RECOMMENDED MAXIMUM HOLDING TIMES AND SAMPLE COLLECTION/PRESERVATION INFORMATION

ENSECO RECOMMENDED MAXIMUM HOLDING TIMES AND SAMPLE COLLECTION/PRESERVATION INFORMATION

A. ORGANICS

Parameter	Method No.	Matrix	Holding Time[a] (from date sampled)	Container	Preservative	Min. Sample Size
Volatile Halocarbons	601	Water	14 days	40 ml VOA vial (duplicate)	4°C	40 ml
	8010	Soil/Waste		core tube or	4°C	10 g
		-Direct Purge	14 days	glass jar		
		-Methanol Extn.	14 days extn. 7 days anal.			
Volatile Aromatics	602[b]	Water	7 days[b]	40 ml VOA vial (duplicate)	4°C	40 ml
	8020	Soil/Waste		core tube or	4°C	10 g
		-Direct Purge	14 days	glass jar		
		-Methanol Extn.	14 days extn. 7 days anal.			
Phenols	604	Water	7 days extn. 40 days anal.	One liter glass	4°C	1,000 ml
	8040	Soil/Waste	14 days extn. 40 days anal.	core tube or glass jar	4°C	50 g
Phthalate Esters	606	Water	7 days extn. 40 days anal.	One liter glass	4°C	1,000 ml
	8060	Soil/Waste	14 days extn. 40 days anal.	core tube or glass jar	4°C	50 g
OC Pesticides/ PCB's	608	Water	7 days extn. 40 days anal.	One liter glass	4°C	1,000 ml
	8080	Soil/Waste	14 days extn. 40 days anal.	core tube or glass jar	4°C	50 g
Polyaromatic Hydrocarbons	610	Water	7 days extn. 40 days anal.	One liter glass	4°C	1,000 ml
	8310	Soil/Waste	14 days extn. 40 days anal.	core tube or glass jar	4°C	50 g

A. ORGANICS (Cont.)

Parameter	Method No.	Matrix	Holding Time[a] (from Date Sampled)	Container	Preservative	Min. Sample Size
OP Pesticides	614	Water	7 days extn. 40 days anal.	One liter glass	4°C	1,000 ml
	8140	Soil/Waste	14 days extn. 40 days anal.	core tube or glass jar	4°C	50 g
Phenoxy Acid Herbicides	615	Water	7 days extn. 40 days anal.	One liter glass	4°C	1,000 ml
	8150	Soil/Waste	14 days extn. 40 days anal.	core tube or glass jar	4°C	50 g
Volatiles	624	Water	7 days[b]	40 ml VOA vial (duplicate)	4°C	40 ml
	8240	Soil/Waste -Direct Purge -Methanol Extn.	14 days 14 days extn. 7 days anal.	core tube or glass jar	4°C	10 g
Semivolatiles	625	Water	7 days extn. 40 days anal.	One liter glass	4°C	1,000 ml
	8270	Soil/Waste	14 days extn. 40 days anal.	core tube or glass jar	4°C	50 g
Carbamate & Urea Pesticides	632	Water	7 days extn. 40 days anal.	One liter glass	4°C	1,000 ml
	632-S	Soil/Waste	14 days extn. 40 days anal.	core tube or glass jar	4°C	50 g
Dioxins/Furans	8280-W	Water	7 days extn. 40 days anal.	One liter glass	4°C	1,000 ml
	8280	Soil/Waste	None required	core tube or glass jar	4°C	50 g
Petroleum Hydrocarbons	PH-GC	Water	7 days extn. 40 days anal.	One liter glass	4°C and H_2SO_4	500 ml
	PH-GC	Soil/Waste	14 days anal. 40 days anal.	core tube or glass jar	4°C	50 g

(a) extn.: extraction anal.: analysis; (b) If preserved with HCl: 14 day holding time

B. METALS

Parameter	Method No.	Matrix	Holding Time[a] (from Date Sampled)	Container	Preservative	Min. Sample Size
Metals (ICP)	200.7	Water	6 months	Poly	HNO_3 to pH < 2.0	100 ml
	6010	Soil/Waste	6 months	core tube/glass jar	4°C	10 g
Arsenic (GF-AA)	206.2	Water	6 months	Poly	HNO_3 to pH < 2.0	100 ml
	7060	Soil/Waste	6 months	core tube/glass jar	4°C	10 g
Mercury (CV-AA)	245.1	Water	28 days	Poly	HNO_3 to pH < 2.0	100 ml
	7470	Soil/Waste	28 days	core tube/glass jar	4°C	10 g
Selenium (GF-AA)	270.2	Water	6 months	Poly	HNO_3 to pH < 2.0	100 ml
	7740	Soil/Waste	6 months	core tube/glass jar	4°C	10 g
Thallium (GF-AA)	279.2	Water	6 months	Poly	HNO_3 to pH < 2.0	100 ml
	7841	Soil/Waste	6 months	core tube/glass jar	4°C	10 g
Lead (GF-AA)	239.2	Water	6 months	Poly	HNO_3 to pH < 2.0	100 ml
	7421	Soil/Waste	6 months	core tube/glass jar	4°C	10 g
Chromium (III/VI)	312B	Water	24 hours	Poly	4°C	100 ml
	312B	Soil/Waste	24 hours extn. [b]	core tube/glass jar	4°C	10 g
Silica	200.7	Water	28 days	Poly	4°C	100 ml
	6010	Soil/Waste	28 days	core tube/glass jar	4°C	10 g

(a) Listed preservative is for total metals. Dissolved or suspended metals require filtration prior to pH adjustment.

5. SAMPLE CUSTODY

Upon receipt by Enseco, samples proceed through an orderly processing sequence specifically designed to ensure continuous integrity of both the sample and its documentation.

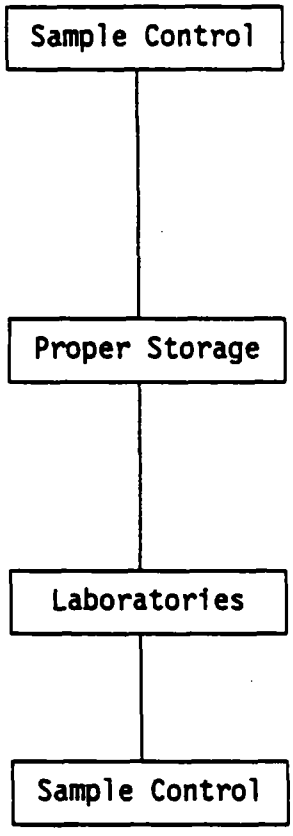
All samples are received by Enseco's Sample Control Group and are carefully checked for label identification, and completed, accurate chain-of-custody records. Photographs document the condition of samples and each sample is then assigned a unique laboratory identification number through a computerized Laboratory Data Management System (LDMS) that stores all identifications and essential information. The LDMS system and internal chain-of-custody procedures track the sample from storage through the laboratory system until the analytical process is complete and the sample is back in the custody of Sample Control for disposal or return to the client. This process is summarized in Figure 5-1. Access to all Enseco laboratories is restricted to prevent any unauthorized contact with samples, extracts, or documentation.

An example of the Enseco Chain-Of-Custody Record used to transmit samples from the client to the laboratory is given in Figure 5-2. The Chain-Of-Custody Record (Interlaboratory Analysis Form) used to transmit samples between laboratories within Enseco is given in Figure 5-3.

In addition, sample bottles provided to the client by Enseco are transmitted under custody using the Enseco "Sample Safe™".

Figure 5-1

ENSECO SAMPLE PROCESSING FLOW CHART



* Check and document physical condition of sample
* Verify documentation and parameter assignment
* Log into LDMS
* Send acknowledgement letter to client

* Store sample according to preservation guidelines
* Transfer sample to lab with proper documentation

* Document analytical work
* Return unused samples to Sample Control

* Return sample to client or arrange for sample disposal

Enseco

CHAIN OF CUSTODY

No.

Attn: _____

Enseco Client _____

Project _____

Sampling Co. _____

Sampling Site _____

Team Leader _____

SAMPLE SAFE™ CONDITIONS

1. Packed by: _____ Seal # _____
2. Seal Intact Upon Receipt by Sampling Co.: Yes No
3. Condition of Contents: _____
4. Sealed for Shipping by: _____
5. Initial Contents Temp.: _____ °C Seal # _____
6. Sampling Status: Done Continuing Until _____
7. *Seal Intact Upon Receipt by Laboratory:* Yes No
8. Contents Temperature Upon Receipt by Lab: _____ °C
9. Condition of Contents: _____

Date	Time	Sample ID/Description	Sample Type	No. Containers	Analysis Parameters	Remarks

CUSTODY TRANSFERS PRIOR TO SHIPPING

	Relinquished by: (signed)	Received by: (signed)	Date	Time
1				
2				
3				

SHIPPING DETAILS

Delivered to Shipper by: _____

Method of Shipment: _____ Airbill # _____

Received for Lab: _____ Signed: _____ Date/Time _____

Enseco Project No. _____

White and Pink Copies to Lab Yellow to Sampler

SS-001

Figure 5-2

Figure 5-3

Page _____ of____
File Index_____

Enseco

INTERLABORATORY ANALYSIS

SHIP TO: *(circle one)*	SEND RESULTS TO:
CAL ERCO CLE GAS MAR HOU	
Attention:	Attention:
CLIENT NAME	PROJECT NO.

Relinquished by: *(Signature)* Received by: *(Signature)* Date Time

Relinquished by: *(Signature)* Received by: *(Signature)* Date Time

Import Lab ID	Enseco ID	Client ID	Matrix (a, s, w)	Date Sampled	Date Rec'd	Date Auth.	Analysis Requested/ P.L. Item #	Sample Condition Upon Receipt

a. Written results required by (date): _____ Verbal results required by (date): _____

b. QC: ☐ Standard Enseco ☐ CLP Protocol ☐ Project-Specific _____

c. Sample Disposal: ☐ Enseco ☐ Return to Client ☐ Phone RMAL

d. Raw Data Copies Needed: ☐ Yes ☐ No

e. Detection Limits: ☐ Standard Product ☐ Other*

f. Holding Times: ☐ Enseco ☐ EPA-CLP ☐ Other*

g. *Special Instructions: _____

h. Intercompany Rebate: *(circle one)* 0% 5% 10% i. P.O. Number _____

6. CALIBRATION PROCEDURES AND FREQUENCY

Standard/Reagent Preparation

A critical element in the generation of quality data is the purity/quality and traceability of the standard solutions and reagents used in the analytical operations. Enseco continually monitors the quality of reagents and standard solutions through a series of well-documented procedures.

To ensure the highest purity possible, all primary reference standards and standard solutions used by Enseco are obtained from the National Bureau of Standards, the EPA Repository or other reliable commercial sources. All standards and standard solutions are logged into a data base that identifies the supplier, lot number, purity/concentration, receipt/preparation date, preparer's name, method of preparation, expiration date, and all other pertinent information.

Standard solutions are validated prior to use. Validation procedures can range from a check for chromatographic purity to verification of the concentration of the standard using a standard prepared at a different time or obtained from a different source. Stock and working standards are checked regularly for signs of deterioration, such as discoloration, formation of precipitates, or change of concentration. Care is exercised in the proper storage and handling of standard solutions, and all containers are labeled as to compound, concentration, solvent, expiration date, and preparation data (initials of preparer/date of preparation).

Reagents are examined for purity by subjecting an aliquot or subsample to the analytical method corresponding to its intended use; for example, every lot of dichloromethane (for organic extractables) is analyzed for undesirable contaminants prior to use in the laboratory.

A data base is used to store essential information on specific standards or reagents. The system is designed to serve various functions (e.g., the system issues warnings on expiration dates and allows chemists to obtain a list of all working standard solutions prepared from the same stock solution). The program also facilitates the management and auditing of reagents and standards.

Instrument Calibration and Tuning

Calibration of instrumentation is required to ensure that the analytical system is operating correctly and functioning at the proper sensitivity to meet established detection limits. Each instrument is calibrated with standard solutions appropriate to the type of instrument and the linear range established for the analytical method. The frequency of calibration and the concentration of calibration standards is determined by the manufacturer's guidelines, the analytical method, or the requirements of special contracts.

Gas Chromatography/Mass Spectrometry (GC/MS)

Each day prior to analysis of samples, the instrument is tuned with bromofluorobenzene (BFB) for volatile compounds and decafluorotriphenylphosphine (DFTPP) for semivolatile compounds (according to the tuning criteria specified in the U.S. EPA CLP). No samples are analyzed until the instrument has met tuning criteria.

The instrument is then calibrated for all target compounds. An initial calibration curve is produced and certain key compounds referred to as system performance calibration compounds (SPCC) and continuing calibration compounds (CCC) are evaluated on a daily basis to ensure that the system is within calibration. If the daily standard does not meet the established criteria, the system is recalibrated.

Chromatography

The field of chromatography involves a variety of instrumentation and detection systems. While calibration standards and acceptance criteria vary depending on the type of system and analytical methodology required for a specific analysis, the general principles of calibration apply uniformly. Each chromatographic system is calibrated prior to performance of analyses. Initial calibration consists of determining the linear range, establishing limits of detection, and establishing retention time windows. The calibration is checked on a daily basis to ensure that the system remains within specifications. If the daily calibration check does not meet established criteria, the system is recalibrated and samples analyzed since the last acceptable calibration check are reanalyzed.

Metals

Metals analysis basically involves two types of analytical instrumentation: inductively coupled argon plasma emission spectroscopy (ICP), and atomic absorption spectroscopy (AA).

Each ICP is calibrated prior to the analyses being performed using criteria prescribed in the CLP protocol. The calibration is then verified using standards from an independent source. The linear range of the instrument is established once every quarter using a linear range verification check standard. No values are reported above this upper concentration value without dilution.

A calibration curve is established daily by analyzing a minimum of two standards, one of which is a calibration blank. The calibration is monitored throughout the day by analyzing a continuing calibration blank (CCB) and a continuing calibration verification standard (CCV). The standard must meet established criteria or the system is recalibrated and all samples analyzed since the last acceptable calibration check are reanalyzed.

An interelement check standard is analyzed at the beginning and end of each analytical run, and on a continuing basis, to verify that interelement and background correction factors have remained constant. Results outside of the established criteria trigger reanalysis of samples.

Each AA unit is calibrated prior to analyses being conducted. A calibration curve is prepared with a minimum of a calibration blank and three standards and then verified with a standard that has been prepared from an independent source at a concentration near the middle of the calibration range. The calibration is verified on an ongoing basis with a midpoint calibration standard. If the ongoing calibration standard does not meet established acceptance criteria, the system is recalibrated and all samples analyzed since the last acceptable calibration check are reanalyzed. All samples are spiked to verify the absence of matrix effects or interferences. The method of standard additions is used when matrix interferences are present.

Conventional Analyses

The field of conventional, non-metals analysis involves a variety of instrumental and wet chemical techniques. While calibration and standardization procedures vary depending on the type of system and analytical methodology required for a specific analysis, the general principles of calibration apply universally. Each system or method is calibrated prior to analyses being conducted. Calibration consists of defining the linear range by use of a series of standard solutions, establishing limits of detection, and identifying potential interferences. The calibration is checked on an ongoing basis to ensure that the system remains within specifications. If the ongoing calibration check does not meet established criteria, the system is recalibrated and all samples analyzed since the last acceptable calibration check are reanalyzed.

7. ANALYTICAL PROCEDURES

Most analyses performed by Enseco are driven by regulatory concerns. Therefore, methods used at Enseco predominantly originate from regulatory agencies. Generally the methods used are those specified by the U.S. EPA and other federal agencies, state agencies, and professional organizations, as provided in the following references:

- Current EPA (CLP) protocols for the analysis of organic and inorganic hazardous substances including chlorinated dioxins and furans.
- "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act," 40 CFR, Part 136.
- "Methods for Chemical Analysis of Water and Wastes," EPA-600/4-79-020 (revised March, 1983).
- "Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater," EPA-600/4-82-057 (July, 1982).
- "Test Methods for Evaluating Solid Waste" (SW-846), 2nd Edition (revised), Update I (1984), Update II (1985), 3rd Edition (1986), Office of Solid Waste and Emergency Response, U.S. EPA.
- "Standard Methods for the Examination of Water and Wastewater," 16th Edition, American Public Health Association, American Water Works Association, Water Pollution Control Federation, Washington, DC (1985).
- "Official Methods of Analysis," 14th Edition, Association of Official Analytical Chemists, Arlington, VA (1984).
- "Methods for the Determination of Organic Compounds in Finished Drinking Water and Raw Source Water," U.S. EPA, Environmental Monitoring and Support Laboratory - Cincinnati (September, 1986).
- "Annual Book of ASTM Standards," Volumes 11.01 and 11.02, American Society for Testing and Materials (ASTM), Philadelphia, PA (1987).
- "Techniques of Water Resources Investigations of the United States Geological Survey (USGS), Book 5, Laboratory Analysis," USGS, Washington, DC (1979).

The choice of method is dependent on the objectives of the study in terms of qualitative certainty, quantitative sensitivity, precision and accuracy, and the type of matrix to be analyzed. Each method used routinely is documented in the form of an SOP. The SOP contains detailed instructions concerning the both the use and the expected performance of the method. Any deviations from published methodology are documented and explained in the SOP. A complete description of the contents of laboratory SOP'S is given in Section 15.

Before any methods are routinely used to generate analytical data, the method is validated. Validation criteria consist of:

- Method selection by a senior staff member;
- Documentation of the method in an SOP. This includes a summary of the method, detailed description of the analytical procedure, calculations, reporting formats, safety concerns, and special remarks;
- Testing of the method to verify detection limits and linear range and establish precision and accuracy criteria; and
- Establishment of data acceptance criteria that must be approved by a senior staff member and the Division QA Director.

8. DATA REDUCTION, VALIDATION, AND REPORTING

Data Reduction and Validation

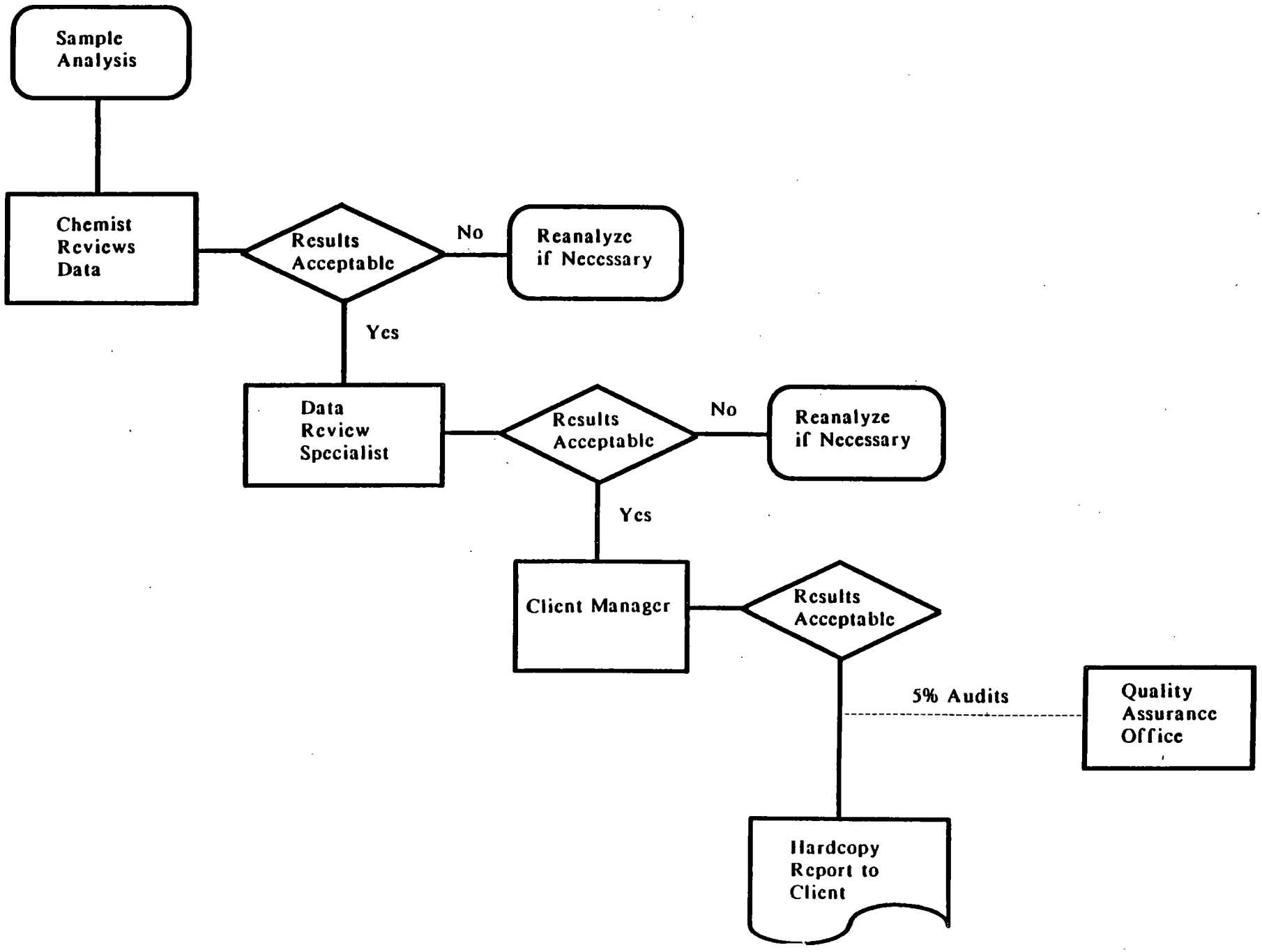
All analytical data generated within Enseco laboratories are extensively checked for accuracy and completeness. The data validation process consists of data generation, reduction, and three levels of review, as described below (also see Figure 8-1).

The analyst who generates the analytical data has the prime responsibility for the correctness and completeness of the data. All data are generated and reduced following protocols specified in laboratory SOP'S. Each analyst reviews the quality of his work based on an established set of guidelines. The analyst reviews the data package to ensure that:

- Sample preparation information is correct and complete;
- Analysis information is correct and complete;
- The appropriate SOP'S have been followed;
- Analytical results are correct and complete;
- QC samples are within established control limits;
- Blank correction procedures have been followed;
- Special sample preparation and analytical requirements have been met; and
- Documentation is complete (e.g., all anomalies in the preparation and analysis have been documented, Out-of-Control forms [if required] are complete; holding times are documented, etc.).

Figure 8-1

Data Validation Scheme



The data reduction and validation steps are documented, signed and dated by the analyst. This initial review step, performed by the analyst, is designated Level 1 review. The analyst then passes the data package to an independent reviewer, who performs a Level 2 review.

Level 2 review is performed by a data review specialist whose function is to provide an independent review of the data package. This review is also conducted according to an established set of guidelines and is structured to ensure that:

- Calibration data are scientifically sound, appropriate to the method, and completely documented;
- QC samples are within established guidelines;
- Qualitative identification of sample components is correct;
- Quantitative results are correct;
- Documentation is complete and correct (e.g., anomalies in the preparation and analysis have been documented; Out-of-Control forms [if required] are complete; holding times are documented, etc.);
- The data are ready for incorporation into the final report; and
- The data package is complete and ready for data archive.

Level 2 review is structured so that all calibration data and QC sample results are reviewed and all of the analytical results from 10% of the samples are checked back to the bench sheet. If no problems are found with the data package, the review is complete. If any problems are found with the data package, an additional 10% of the samples are checked to the bench sheet. The process continues until no errors are found or until the data package has been reviewed in its entirety.

An important element of Level 2 review is the documentation of any errors that have been identified and corrected during the review process. Enseco believes that the data package submitted by the analyst for Level 2 review should be free of errors. Errors that are found are documented and transmitted to the appropriate supervisor. The cause of the errors is then addressed with additional training or clarification of procedures to ensure that quality data will be generated at the bench.

Level 2 data review is also documented and the signature of the reviewer and the date of review recorded. The reviewed data are then approved for release and a final report is prepared.

Before the report is released to the client, the client manager reviews the report to ensure that the data meet the overall objectives of the client, as understood by the client manager. This review is labeled Level 3 review.

In addition, the Divisional QA department randomly audits 5% of all projects reported. The QA audit includes verifying that holding times have been met, calibration checks are adequate, qualitative and quantitative results are correct, documentation is complete and QC results are complete and accurate. During the review, the QA department checks the data from 20% of the samples back to the bench sheet. If no problems are found with the data package, the review is complete. If any problems are found with the data package, an additional 10% of the samples are checked to the bench sheet. The process continues until no errors are found or until the data package has been reviewed in its entirety.

Data Reporting

A variety of reporting formats, from computerized data tables, to complex reports discussing regulatory issues, to a CLP-deliverables package, are available. In general, Enseco reports contain:

General Discussion: Description of samples types, tests performed, any problems encountered and general comments are given.

Analytical Data: Data are reported by sample, by test, and are blank corrected (see Section 9). Pertinent information including dates sampled, received, prepared, and extracted are included on each results page. The Enseco reporting limit and regulatory limit (if appropriate) for each analyte is also given.

QC Information: Analytical results for laboratory blanks are given. Also, the results (percent recovery and relative percent difference) of the LCS/SCS (see Section 9) analyzed with the project are listed. Control limits are given and out-of-control values are flagged.

Results of any matrix spikes, duplicates, matrix spike duplicates or other project-specific QC are also reported.

Methodology: Reference for analytical methodology used is cited.

Custom Services: Special services including data interpretation, special consultation, and raw data packages (when requested) are included.

9. INTERNAL QC CHECKS

The Enseco QA/QC program monitors data quality with internal QC checks. Internal QC checks are used to answer two questions:

1) Are laboratory operations "in control," (i.e., operating within acceptable QC guidelines), during data generation?

2) What effect does the sample matrix have on the data being generated?

The first question is answered by laboratory performance QC. Laboratory performance QC is based on the use of a standard, control matrix to generate precision and accuracy data that are compared, on a daily basis, to control limits. This information, in conjunction with reagent blank data, is used to access daily laboratory performance.

The second question is addressed with matrix specific QC. Matrix specific QC is based on the use of an actual environmental sample for precision and accuracy determinations and commonly relies on the analysis of matrix spikes, matrix duplicates, and matrix spike duplicates. This information, supplemented with field blank results, is used to assess the effect of the matrix and field conditions on analytical data.

Laboratory Performance QC is provided as a standard part of every routine Enseco analysis. Matrix Specific QC is available as an option to the client and should be specified based on the types of matrices to be analyzed and the data quality and regulatory requirements of the project.

A complete discussion of the Enseco Internal QC Check program follows.

Laboratory Performance QC Program

Laboratory Performance QC is provided as a standard part of every routine Enseco analysis. The main elements of Laboratory Performance QC are:

- The analysis of Laboratory Control Samples (LCS) and Surrogate Control Samples (SCS);
- The analysis of reagent blanks; and
- The generation of daily calibration data.

The LCS/SCS program and the analysis of reagent blanks are discussed below. Please refer to Section 6 of this manual for a discussion of calibration procedures.

The LCS Program

The LCS is used to monitor the laboratory's day-to-day performance of routine analytical methods. An LCS consists of a standard, control matrix that is spiked with a group of target compounds representative of the method analytes. The LCS is analyzed with environmental samples to provide evidence that the laboratory is performing the method within accepted QC guidelines.

Accuracy (recovery) and precision (Relative Percent Difference [RPD]) data from the LCS are compared to control limits that have been established for each of the analytes monitored in the LCS. Initially, control limits for analytes spiked into the LCS are taken directly from the CLP program. If CLP limits are not available, Enseco historical data are used to set the control limits. As sufficient laboratory data become available, the control limits are redefined based upon the most recent six months of LCS data. Control limits for accuracy are based on the historical average recovery of the LCS plus or minus three standard deviation units. Control limits for precision are based on the historical RPD and range from zero

(no difference between duplicate LCS results) to the average RPD plus three standard deviation units. Calculated control limits tend to be tighter than CLP limits because of the use of a control matrix. However, if the calculated limits are broader than the CLP limits, the CLP limits are used to control the laboratory.

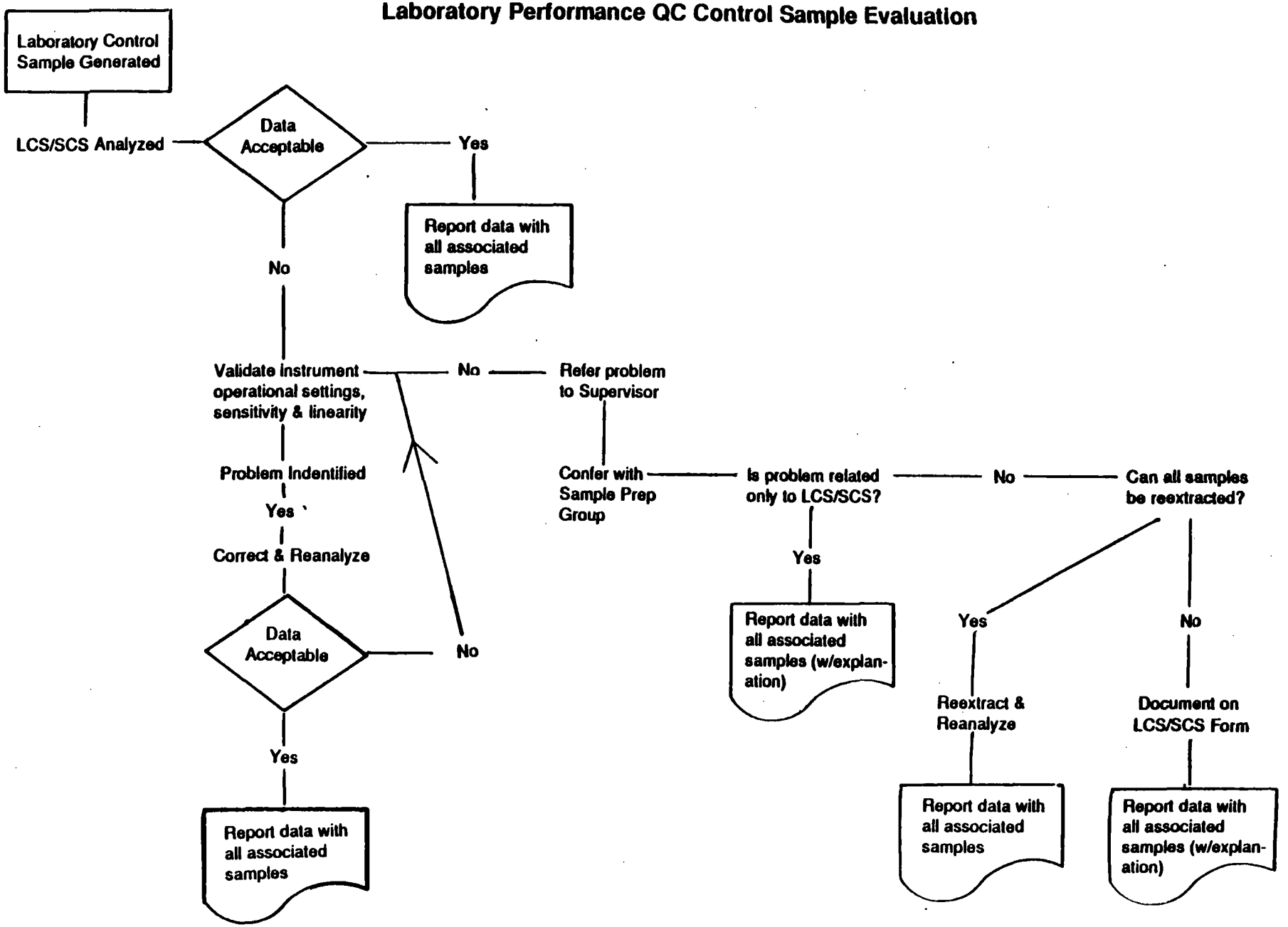
Analytical data that are generated with an LCS which falls within the established control limits are judged to be in control. Data generated with an LCS which falls outside of the control limits are considered suspect and are repeated or reported with qualifiers. The procedure used to evaluate data from control samples is given in Figure 9-1. The protocols include examination of instrument performance and preparation and analysis information, consultation with the supervisor, and finally a decision path for determining whether reanalysis is warranted.

An LCS has been established for each routine analytical method. Reagent water is used as the control matrix for the analysis of aqueous samples. The LCS compounds are spiked into reagent water and carried through the appropriate steps of the analysis. As stated in SW-846, Third Edition, a universal blank matrix does not exist for solid samples and therefore no matrix is used. The LCS for solid samples consists of the LCS compounds spiked into a reagent blank and carried through the appropriate steps of the analysis.

The LCS is analyzed at a frequency of no less than one pair of duplicate LCS per 20 samples. The LCS program is supplemented with the SCS program to ensure that laboratory performance QC is available with each batch of samples processed (see following subsection).

LCS precision and accuracy data are archived in the LDMS. In addition, the associated LCS data are reported with each set of sample results to allow the client to make a quality assessment of the data.

Figure 9-1
Laboratory Performance QC Control Sample Evaluation



The SCS Program

As stated above, duplicate LCS are performed for every 20 samples to measure the precision and accuracy of an analysis on an ongoing basis. However, samples are often analyzed in lots of less than 20, due to holding time or turn-around time requirements. Since it is necessary to have a measure of laboratory performance with each batch of samples processed, Enseco has instituted the SCS program.

An SCS consists of a control matrix that is spiked with surrogate compounds appropriate to the method being used. In cases where no surrogate is available, (e.g., metals or conventional analyses) a single LCS serves as the control sample. An SCS is prepared for each sample lot for which the duplicate LCS are not analyzed. Recovery data generated from the SCS are compared to control limits that have been established for each of the surrogates being monitored. Initially, CLP control limits or Enseco historical data are used to set the control limits. When sufficient SCS data are available, control limits are redefined based on the most recent six months of data. Control limits for SCS components are based on the historical average recovery in the SCS plus or minus three standard deviation units.

Analytical data that are generated with an SCS which falls within the control limits are judged to be in control. Data that are generated with an SCS which falls outside of acceptance criteria are considered suspect and are reanalyzed or reported with qualifiers. The protocols for evaluating SCS are identical to those established for LCS (see Figure 9-1).

SCS recovery (accuracy) data are archived in the LDMS. In addition, the associated SCS data are reported with each set of sample results to allow the client to make a quality assessment of the data.

Reagent Blanks

Reagent or analytical blanks are analyzed to assess the level of contamination which exists in the analytical system and which might lead to the reporting of elevated concentration levels or false positive data.

As part of the standard Enseco QC program, an analytical blank is analyzed with every batch of samples that is processed. An analytical blank consists of reagents specific to the method that are carried through every aspect of the procedure, including preparation, clean-up, and analysis. Ideally, the concentration of an analyte in the blank is below the reporting limit for that analyte. However, some common laboratory solvents and metals are difficult to eliminate to the parts-per-billion levels commonly reported in environmental analyses. Therefore, analytical data are corrected for blank contamination before it is reported to the client.

The protocol for blank correction of data is as follows:

1) If the blank value is above the detection limit but below the Enseco reporting limit, the blank value is subtracted from the sample, the reporting limit remains unchanged.

Example: EPA Method 624/HSL

Chloromethane	Reporting Limit = 10 ug/L
Blank Value = 8 ug/L	Sample = 12 ug/L

Report the analyte as "Not Detected" (ND) with a reporting limit at 10 ug/L.

2) If the blank value lies between the reporting limit and three times the reporting limit, the blank value is subtracted from the sample, and the reporting limit adjusted to the level found in the blank.

Example: EPA Method 624/HSL

Chloromethane	Reporting Limit = 10 ug/L
Blank Value = 15 ug/L	Sample = 25 ug/L

Report the sample as ND with a reporting limit of 15 ug/L.

3) If the blank value lies above three times the reporting limit, the supervisor is consulted to schedule the blank and all samples associated with the blank for repreparation and/or reanalysis.

Matrix Specific QC

Matrix specific QC is used to assess the effects of a sample matrix or field conditions on the analytical data. The main elements of matrix specific QC are:

- The analysis of matrix spikes, matrix duplicates, and matrix spike duplicates;
- Monitoring the recovery of surrogate compounds from environmental samples;
- Monitoring the results of standard additions in environmental samples;
- The analysis of field blanks; and
- The determination of method detection limits in a specific matrix.

Different regulatory programs have different requirements in terms of matrix specific QC (see Table 9-2). In order to ensure that the data generated meet all data quality objectives, Enseco encourages its clients to include matrix specific QC that fulfills the data quality objectives and regulatory requirements of the project. A discussion of the different elements of matrix specific QC follows.

TABLE 9-2

FREQUENCY OF QUALITY CONTROL SAMPLES

Analytes	Methods	Blanks		Duplicates			Matrix Spike Sample	Lab Control Sample	Surrogates	PE Samples
		Method Blank	Field Blank	Field Dup.	Dup. Samples	Spike Dup.				
RCRA										
Soil, Waste Samples										
GC "8000" Series	8010-8150•	ESS	NS	-	ESS	ESS	ESS	-	100%	-
GC/MS VOA	8240•	Daily	NS	-	ESS	ESS	ESS	-	CLP	-
GC/MS Semivolatiles	8250,8270•	ESS	NS	-	ESS	ESS	ESS	-	CLP	-
Dioxin & Furans	8280•	ESS	NS	NS	ESS	-	ESS	-	CLP	NS
HPLC (PAH)	8310•	ESS	NS	-	ESS	-	ESS	-	-	-
Metals - Acid Dig.	3000	ESS	NS	NS	20%	-	ESS	ESS	-	-
AA	7000	ESS	NS	NS	5%	5%, 10%	20%	-	-	-
ICP	6010•	ESS	NS	NS	5%	20%	5%	-	-	-
CERCLA - Superfund (CLP)										
Water, Soil, Waste Samples										
GC - Pest. & PCB's	608-CLP	5%, ESS	Rec	-	-	5%, ESS	5%, ESS	-	Req	Qtrly
Dioxin (2378)	613-CLP	ESS	Rec	-	-	5%, ESS	5%, ESS	-	ACC	ESS
GC/MS Purgeables (VOA)	624-CLP	Daily, ESS	Rec	-	-	5%, ESS	5%, ESS	-	ACC	Qtrly
GC/MS Semivolatiles	625-CLP	5%, ESS	Rec	-	-	5%, ESS	5%, ESS	-	ACC	Qtrly
Metals - AA	200.0-CLP	5%, ESS	Rec	-	5%	-	5%, ESS	ESS	-	Qtrly
ICP	200.7-CLP	5%, ESS	Rec	-	5%	-	5%, ESS	ESS	-	Qtrly
CWA										
Water & Wastewater Samples										
GC Purgeables	601-602	Daily	-	NS	-	-	10%	Daily	-	-
GC "600" Series	603-619	ESS	-	NS	-	-	10%	-	-	-
GC/MS Purgeables (VOA)	624	Daily	-	NS	-	-	5%	Daily	Req	-
GC/MS Semivolatiles	625	ESS	-	NS	-	-	5%	-	Req	-
AAS Metals	200.0	ESS	-	NS	Opt., 10%	-	-	-	-	Yearly
ICP Metals	200.7	ESS	-	NS	-	-	-	-	-	-
SDWA										
Finished Drinking Water and Raw Source Water										
Organic "500" Series	502.1-531	Daily	ESS	10%	-	-	-	10%	-	Qtrly
Metals - Same as CWA										

ACC - Surrogates required, acceptance criteria CLP - CLP critera are used ESS - Each samples set NS - Not Specified
Opt - Optional Qtrly - Quarterly Rec - Recommended Req - Surrogates required, no acceptance criteria • SW-846 3rd edition

Matrix Spikes, Matrix Duplicates, and Matrix Spike Duplicates

A Matrix Spike (MS) is an environmental sample to which known concentrations of analytes have been added. The MS is taken through the entire analytical procedure and the recovery of the analytes is calculated. Results are expressed as percent recovery. The MS is used to evaluate the effect of the sample matrix on the accuracy of the analysis.

A Matrix Duplicate (MD) is an environmental sample that is divided into two separate aliquots. The aliquots are processed separately and the results compared to determine the effects of the matrix on the precision of the analysis. Results are expressed as RPD.

A Matrix Spike Duplicate (MSD) is an environmental sample that is divided into two separate aliquots, each of which is spiked with known concentrations of analytes. The two spiked aliquots are processed separately and the results compared to determine the effects of the matrix on the precision and accuracy of the analysis. Results are expressed as RPD and percent recovery.

Surrogate Recoveries and Standard Additions

Surrogates are organic compounds which are similar to the analytes of interest in chemical behavior, but which are not normally found in environmental samples. Surrogates are added to samples to monitor the effect of the matrix on the accuracy of the analysis. Results are reported in terms of percent recovery.

Enseco routinely adds surrogates to samples requiring GC/MS analysis and reports these surrogate recoveries to the client. The surrogate recoveries are used by the laboratory to assess matrix effects. Decisions concerning laboratory performance of the method are based on QC data generated from a control matrix (LCS and SCS).

Standard Additions (SA) is the practice of adding a series of known amounts of an analyte to an environmental sample. The fortified samples are then analyzed and the recovery of the analytes calculated. The practice of SA's is generally used with metal and conventional analyses to determine the effect of the sample matrix on the accuracy of the analyses.

Field Blanks

Field blanks are check samples that monitor contamination originating from the collection, transport or storage of environmental samples. One example of a field blank is an equipment blank. An equipment blank is blank water that is poured through the sample collection device to check the adequacy of the cleaning procedures for the sampling equipment. Another type of field blank is a trip blank. A trip blank is a laboratory control matrix (typically water) which is sent to the field, remains unopened in the field, and then is sent back to the laboratory. The purpose of the trip blank is to assess the impact of field and shipping conditions on the samples. The results from field blanks are reported to the client as samples in the same concentration units as the samples. No correction of the analytical data is done in the laboratory based on the analysis of field blanks.

Matrix Specific Detection Limits

Method Detection Limits (MDL's) determined on a specific sample matrix are called Matrix Specific Detection Limits. See Section 12 for a discussion of detection limits.

10. PERFORMANCE AND SYSTEM AUDITS

Enseco laboratories participate in a variety of federal and state certification programs, (including the U.S. EPA CLP), that subject each of the laboratories to stringent system and performance audits on a regular basis. A system audit is a review of laboratory operations conducted to verify that the laboratory has the necessary facilities, equipment, staff and procedures in place to generate acceptable data. A performance audit verifies the ability of the laboratory to correctly identify and quantitate compounds in blind check samples submitted by the auditing agency. The purpose of these audits is to identify those laboratories that are capable of generating scientifically sound data. Enseco is certified to perform environmental analyses under programs administered by the U.S. EPA, U.S. Army, U.S. Navy, and over 15 states. The most current list of Enseco certifications is available upon request.

In addition to external audits conducted by certifying agencies or clients, Enseco regularly conducts the following internal audits:

- Monthly systems audits conducted by the Division QA Director.
- Quarterly audits conducted by the Corporate VP of QA.
- Special audits by the Divisional QA Director or Corporate VP of QA when a problem is suspected.

Enseco laboratories also routinely analyze internal check samples as described below:

- Laboratory QC check samples (LCS, SCS, and blanks) are analyzed at a frequency equal to at least 10% of the total number of samples analyzed (see Section 9).
- An independent commercial firm is contracted to provide all laboratories with blind check samples on a monthly basis. The results of the analyses of these samples are evaluated by the VP of QA.

The results of these internal check samples are used to identify areas where additional training is needed or clarification of procedures is required.

11. PREVENTIVE MAINTENANCE

To minimize downtime and interruption of analytical work, preventive maintenance is routinely performed on each analytical instrument. Designated laboratory personnel are trained in routine maintenance procedures for all major instrumentation. When repairs are necessary, they are performed by either trained staff or trained service engineers employed by the instrument manufacturer.

Each laboratory has detailed SOP's on file that describe preventive maintenance procedures. The laboratories also maintain detailed logbooks documenting the preventive maintenance and repairs performed on each analytical instrument.

12. SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA QUALITY AND DETERMINE DETECTION LIMITS

Data Quality Assessment

The effectiveness of a QA program is measured by the quality of data generated by the laboratory. Data quality is judged in terms of its precision, accuracy, representativeness, completeness and comparability. These terms are described as follows:

Precision is the degree to which the measurement is reproducible. Precision can be assessed by replicate measurements of reference materials, environmental samples, or LCS. Enseco routinely monitors precision by comparing the RPD between LCS measurements with control limits established at plus three standard deviations from the mean RPD of historical LCS data.

Precision is frequently determined by comparison of replicates. Standard deviation of a sample of size n of measurements of x is commonly used in estimating precision.

Sample standard deviation (S) is calculated as follows:

$$S = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (Xi - \bar{X})^2}$$

where a quantity x (e.g., a concentration) is measured n times.

The relative standard deviation (or sample coefficient of variation, CV), which expresses standard deviation as a percentage of the mean, is generally useful in the comparison of three or more replicates (although it may be applied in the case of n = 2).

C. CONVENTIONALS

Parameter	Method No.	Matrix	Holding Time[a] (from Date Sampled)	Container	Preservative	Min. Sample Size
Color	110.2	Water	48 hours	Poly	4°C	100 ml
Oil and Grease	413.1	Water	28 days	Glass	4°C, H_2SO_4 to pH < 2	1000 ml
Specific Conductance	120.1	Water	28 days	Poly	4°C	50 ml
Acidity	305.1	Water	14 days	Poly	4°C	50 ml
pH	150.1	Water	24 hours	Poly	4°C	50 ml
Alkalinity	310.1	Water	14 days	Poly	4°C	50 ml
Hardness	200.7	Water	6 months	Poly	HNO_3 to pH < 2	50 ml
Biochemical Oxygen Demand	405.1	Water	48 hours	Poly	4°C	200 ml
Chemical Oxygen Demand	410.4	Water	28 days	Glass	4°C, H_2SO_4 to pH < 2	100 ml
Organic Carbon (TOC)	415.1	Water	28 days	Glass	4°C, H_2SO_4 to pH < 2	100 ml

C. CONVENTIONALS (Cont.)

Parameter	Method No.	Matrix	Holding Time[a] (from Date Sampled)	Container	Preservative	Min. Sample Size
Orthophosphate	365.3	Water	48 hours	Poly	4°C	100 ml
T. Phosphorus	365.3	Water	28 days	Glass	H_2SO_4 to pH < 2	100 ml
Total Kjeldahl Nitrogen	351.2	Water	28 days	Glass	4°C, H_2SO_4 to pH < 2	100 ml
Ammonia	350.1	Water	28 days	Glass	4°C, H_2SO_4 to pH < 2	50 ml
Nitrite	354.1	Water	48 hours	Poly	4°C	50 ml
Nitrate	353.2	Water	48 hours	Poly	4°C	50 ml
Nitrite plus Nitrate	353.2	Water	28 days	Glass	4°C, H_2SO_4 to pH < 2	50 ml
Total Solids	160.3	Water	7 days	Poly	4°C	100 ml
Total Suspended Solids	160.2	Water	7 days	Poly	4°C	100 ml
Total Dissolved Solids	160.1	Water	7 days	Poly	4°C	100 ml

C. CONVENTIONALS (Cont.)

Parameter	Method No.	Matrix	Holding Time[a] (from Date Sampled)	Container	Preservative	Min. Sample Size
Total Volatile Solids	160.4	Water	7 days	Poly	4°C	100 ml
Turbidity	180.1	Water	48 hours	Poly	4°C	50 ml
Sulfate	300.0	Water	28 days	Poly	4°C	50 ml
Sulfite	377.1	Water	ASAP	Poly	4°C	100 ml
Sulfide	376.2	Water	7 days	Poly	4°C, NaOH, $Zn(C_2H_3O_2)_2$	100 ml
Cyanide	335.1/ 335.2/335.3	Water	14 days	Poly	4°C, NaOH to pH > 12	250 ml
Coliform, Fecal & Total	909A/ 909C	Water	24 hours	Sterile poly	4°C, $Na_2S_2O_3$	100 ml
Bromide	Dionex	Water	28 days	Poly	4°C	50 ml
Chloride	300.0	Water	28 days	Poly	4°C	50 ml
Chlorine, residual	330.2	Water	24 hours	Poly	4°C	100 ml

C. CONVENTIONALS (Cont.)

Parameter	Method No.	Matrix	Holding Time[a] (from Date Sampled)	Container	Preservative	Min. Sample Size
Fluoride	340.2	Water	28 days	Poly	4°C	50 ml
Iodide	Dionex	Water	NA	Poly	4°C	50 ml
Organic Halogen (TOX)	9020	Water	14 days	Glass	4°C, H_2SO_4 to ph < 2	200 ml
Phenolics	420.1/ 420.2	Water	28 days	Glass	4°C, H_2SO_4 to ph < 2	100 ml
Surfactants	425.1	Water	48 hours	Poly	4°C	100 ml
Gross Alpha, Beta and Radium	9310/ 9315	Water	6 months	Poly	HNO_3 to ph < 2	2,000 ml

a) Parameters with holding times of 24 hours or less are analyzed on the day of receipt in the laboratory. Parameters with holding times between 24 and 48 hours are analyzed within one day of receipt in the laboratory.

NA: Not applicable. No holding time listed in the method.

APPENDIX II

FORMATS FOR STANDARD OPERATING PROCEDURES (SOP)

FORMAT FOR SOP - LABORATORY, ANALYTICAL METHOD

Title (includes method number)

1. Scope and Application
   - 1.1 Analytes
   - 1.2 Detection limit (instrument and method)
   - 1.3 Applicable matrices
   - 1.4 Dynamic range
   - 1.5 Approximate analytical time (i.e., 5 minutes, 2 days)

2. Summary of Method
   - 2.1 Generic description of method and chemistry behind it (i.e., extract with solvent, convert to methyl ester, analyze by electron-capture gas chromatography)

3. Comments
   - 3.1 Interferences
   - 3.2 Helpful hints

4. Safety Issues (specific to the method)

5. Sample Collection, Preservation, Containers, and Holding Times

6. Apparatus

7. Reagents and Standards

8. Procedure (detailed step-by-step)
   - 8.1 Sample preparation
   - 8.2 Calibration
   - 8.3 Analysis

FORMAT FOR SOP - LABORATORY, ANALYTICAL METHOD (cont.)

9. QA/QC Requirements

   9.1 QC samples

   9.2 Acceptance criteria (precision and accuracy, % of multi-component QC analytes which must be within windows)

   9.3 Corrective action required (reference current QC manual)

10. Calculations

11. Reporting

   11.1 Reporting units

   11.2 Reporting limits

   11.3 Significant figures and reporting values below detection limit

   11.4 LDMS data entry

12. References

   12.1 Method source

   12.2 Deviations from source method and rationale

FORMAT FOR SOP - LABORATORY, STANDARDS AND REAGENTS

Title

1. Reagent/Standard Name

2. Type (reagent, calibration standard, LCS, SCS, stock solution, etc.)

3. Constituents/concentration

4. Solvent

5. Safety Issues (specific to the reagent or standard)

6. Shelf Life

7. Procedure

    7.1 Preparation
    7.2 Documentation (purchase date, open date, labeling, etc.)
    7.3 Verification

FORMAT FOR SOP - LABORATORY, EQUIPMENT OPERATION, CALIBRATION, AND MAINTENANCE

Title

1. Purpose

2. Safety Issues (applicable to the specific equipment)

3. Procedure

   3.1 Initial start-up
   3.2 Calibration and performance documentation
   3.3 Example output
   3.4 Shut-down
   3.5 Maintenance and maintenance records

4. Responsibilities

5. Comments

6. Definitions

FORMAT FOR SOP - LABORATORY, PROCEDURAL

Title

1. Purpose

2. Policies

3. Safety Issues

4. Procedure

5. Responsibilities

6. Comments

7. Definitions

ATTACHMENT 2

EPA METHOD TO4, METHOD FOR THE DETERMINATION OF ORGANOCHLORINE PESTICIDES AND POLYCHLORINATED BIPHENYLS IN AMBIENT AIR

METHOD FOR THE DETERMINATION OF ORGANOCHLORINE PESTICIDES AND POLYCHLORINATED BIPHENYLS IN AMBIENT AIR

1. Scope

1.1 This document describes a method for determination of a variety of organochlorine pesticides and polychlorinated biphenyls (PCBs) in ambient air. Generally, detection limits of >1 ng/m^3 are achievable using a 24-hour sampling period.

1.2 Specific compounds for which the method has been employed are listed in Table 1. Several references are available which provide further details on the development and application of the method. The sample cleanup and analysis methods are identical to those described in U. S. EPA Method 608. That method is included as Appendix A of this methods compendium.

2. Applicable Documents

2.1 ASTM Standards

D1356 Definition of Terms Related to Atmospheric Sampling and Analysis (7).

2.2 Other Documents

Ambient Air Studies (1-3)

U. S. EPA Technical Assistance Document (4).

U. S. EPA Method 608 (5). See Appendix A of methods compendium.

3. Summary of Method

3.1 A modified high volume sampler consisting of a glass fiber filter with a polyurethane foam (PUF) backup absorbent cartridge is used to sample ambient air at a rate of ~200-280 L/minute.

3.2 The filter and PUF cartridge are placed in clean, sealed containers and returned to the laboratory for analysis. The PCBs and pesticides are recovered by Soxhlet extraction with 5% ether in hexane.

3.3 The extracts are reduced in volume using Kuderna-Danish (K-D) concentration techniques and subjected to column chromatographic cleanup.

3.4 The extracts are analyzed for pesticides and PCBs using gas chromatography with electron capture detection (GC-ECD), as described in U. S. EPA Method 608 (5).

4. Significance

4.1 Pesticides, particularly organochlorine pesticides, are widely used in both rural and urban areas for a variety of applications. PCBs are less widely used, due to extensive restrictions placed on their manufacture. However, human exposure to PCBs continues to be a problem because of their presence in various electrical products.

4.2 Many pesticides and PCBs exhibit bioaccumulative, chronic health effects and hence monitoring ambient air for such compounds is of great importance.

4.3 The relatively low levels of such compounds in the environment requires the use of high volume sampling techniques to acquire sufficient sample for analysis. However, the volatility of these compounds prevents efficient collection on filter media. Consequently, this method utilizes both a filter and a PUF backup cartridge which provides for efficient collection of most organochlorine pesticides, PCBs, and many other organics within the same volatility range.

5. Definitions

Definitions used in this document and any user-prepared SOPs should be consistent with ASTM D1356 (7). All abbreviations

and symbols are defined within this document at the point of use.

6. Interferences

6.1 The use of column chromatographic cleanup and selective GC detection (GC-ECD) minimizes the risk of interference from extraneous organic compounds. However, the fact that PCBs as well as certain organochlorine pesticides (e.g. toxaphene and chlordane) are complex mixtures of individual compounds can cause difficulty in accurately quantifying a particular formulation in a multiple component mixture.

6.2 Contamination of glassware and sampling apparatus with traces of pesticides or PCBs can be a major source of error in the method, particularly when sampling near high level sources (e.g. dumpsites, waste processing plants, etc.) careful attention to cleaning and handling procedures is required in all steps of the sampling and analysis to minimize this source of error.

7. Apparatus

7.1 Hi-Vol Sampler with PUF cartridge - available from General Metal Works (Model PS-1). See Figure 1.

7.2 Sampling Head to contain glass cartridge with PUF plug - available from General Metal Works. See Figure 2.

7.3 Calibration orifice - available from General Metal Works.

7.4 Manometer - to use with calibration orifice.

7.5 Soxhlet extraction system - including Soxhlet extractors (500 and 250 mL), heating mantels, variable voltage transformers, and cooling water source - for extraction of PUF cartridges before and after sampling. Also for extraction of filter samples.

7.6 Vacuum oven connected to water aspirator - for drying extracted PUF cartridges.

7.7 Gas chromatograph with electron capture detector - (consult U. S. EPA Method 608 for specifications).

7.8 Forceps - to handle quartz fiber filter samples.

7.9 Die - to cut PUF plugs.

7.10 Various items for extract preparation, cleanup, and analysis - consult U. S. EPA Method 608 for detailed listing.

7.11 Chromatography column - 2 mm I.D. x 15 cm long - for alumina cleanup.

8. Reagent and Materials

8.1 Polyurethane foam - 3 inch thick sheet stock, polyether type used in furniture upholstering. Density 0.022 g/cm^3.

8.2 Polyester gloves - for handling PUF cartridges and filters

8.3 Filters, quartz fiber - Pallflex 2500 QAST , or equivalent.

8.4 Wool felt filter - 4.9 mg/cm^2 and 0.6 mm thick. To fit sample head for collection efficiency studies. Pre-extracted with 5% diethyl ether in hexane.

8.5 Hexane - Pesticide or distilled in glass grade.

8.6 Diethyl ether - preserved with 2% ethanol - distilled in glass grade, or equivalent.

8.7 Acetone - Pesticide or distilled in glass grade,

8.8 Glass container for PUF cartridges.

8.9 Glass petri dish - for shipment of filters to and from the laboratory.

8.10 Ice chest - to store samples at ~0°C after collection.

8.11 Various materials needed for extract preparation, cleanup, and analysis - consult U. S. EPA Method 608 for details (Appendix A of this compendium).

8.12 Alumina - activity grade IV. 100/200 mesh

9. Assembly and Calibration of Sampling Apparatus

9.1 Description of Sampling Apparatus

9.1.1 The entire sampling system is diagrammed in Figure 1. This sampler was developed by Syracuse University

Research Corporation (SURC) under a U. S. EPA contract (6) and further modified by Southwest Research Institute and the U. S. EPA. A unit specifically designed for this method is now commercially available (Model PS-1 - General Metal Works, Inc., Village of Cleves, Ohio). The method writeup assumes the use of the commercial device, although the earlier modified device is also considered acceptable.

9.1.2 The sampling module (Figure 2) consists of a glass sampling cartridge and an air-tight metal cartridge holder. The PUF plug is retained in the glass sampling cartridge.

9.2 Calibration of Sampling System

9.2.1 The airflow through the sampling system is monitored by a venturi/Manehelic assembly, as shown in Figure 1. A multipoint calibration of the venturi/magnehelic assembly must be conducted every six months using an audit calibration orifice, as described in the U. S. EPA High Volume Sampling Method (8). A single point calibration must be performed before and after each sample collection, using the procedure described below.

9.2.2 Prior to calibration a "dummy" PUF cartridge and filter are placed in the sampling head and the sampling motor is activated. The flow control valve is fully opened and the voltage variator is adjusted so that a sample flow rate corresponding to ~110% of the desired flow rate is indicated on the magnehelic (based on the previously obtained multipoint calibration curve). The motor is allowed to warmup for ~10 minutes and then the flow control valve is adjusted to achieve the desired flow rate. The ambient temperature and barometric pressure should

be recorded on an appropriate data sheet (e.g. Figure 3).

9.2.3 The calibration orifice is then placed on the sampling head and a manometer is attached to the tap on the calibration orifice. The sampler is momentarily turned off to set the zero level of the manometer. The sampler is then switched on and the manometer reading is recorded, once a stable reading is achieved. The sampler is then shut off.

9.2.4 The calibration curve for the orifice is used to calculate sample flow from the data obtained in 9.2.3, and the calibration curve for the venturi/ magnehelic assembly is used to calculate sample flow from the data obtained in 9.2.2. The calibration data should be recorded on an appropriate data sheet (e.g. Figure 3). If the two values do not agree within 10% the sampler should be inspected for damage, flow blockage, etc. If no obvious problems are found the sampler should be recalibrated (multipoint) according to the U. S. EPA High Volume Sampling procedure (8).

9.2.5 A multipoint calibration of the calibration orifice, against a primary standard, should be obtained annually.

10. Preparation of Sampling (PUF) Cartridges

10.1 The PUF adsorbent is a polyether-type polyurethane foam (density No. 3014 or 0.0225 g/cm^3). This type of foam is used for furniture upholstery. It is white and yellows on exposure to light.

10.2 The PUF inserts are 6.0 cm diameter cylindrical plugs cut from 3 inch sheet stock and should fit with slight compression in the glass cartridge, supported by the wire

screen. See Figure 2. During cutting the die is rotated at high speed (e.g. in a drill press) and continuously lubricated with water.

10.3 For initial cleanup the PUF plug is placed in a Soxhlet extractor and extracted with acetone for 14-24 hours at approximately 4 cycles per hour. When cartridges are reused, 5% diethyl ether in n-hexane can be used as the cleanup solvent.

10.4 The extracted PUF is placed in a vacuum oven connected to a water aspirator and dried at room temperature for approximately 2-4 hours (until no solvent odor is detected).

10.5 The PUF is placed into the glass sampling cartridge using polyester gloves. The module is wrapped with hexane rinsed aluminum foil, placed in a labeled container and tightly sealed.

10.6 Other adsorbents may be suitable for this method as indicated in the various references (1-3). If such materials are employed the user must define appropriate preparation procedures based on the information contained in these references.

10.7 At least one assembled cartridge from each batch must be analyzed, as a laboratory blank, using the procedures described in Section 12, before the batch is considered acceptable for field use. A blank level of <10 ng/plug for single compounds is considered to be acceptable. For multiple component mixtures (e.g. Arochlors) the blank level should be <100 ng/plug.

11. Sampling

11.1 After the sampling system has been assembled and calibrated as described in Section 9 it can be used to collect air samples as described below.

11.2 The samples should be located in an unobstructed area, at least two meters from any obstacle to air flow. The exhaust hose should be stretched out in the downwind

direction to prevent recycling of air.

11.3 A clean sampling cartridge and quartz fiber filter are removed from sealed transport containers and placed in the sampling head using forceps and gloved hands. The head is tightly sealed into the sampling system. The aluminum foil wrapping is placed back in the sealed container for later use.

11.4 The zero reading of the Magnehelic is checked. Ambient temperature, barometric pressure, elapsed time meter setting, sampler serial number, filter number and PUF cartridge number are recorded. A suitable data sheet is shown in Figure 4.

11.5 The voltage variator and flow control valve are placed at the settings used in 9.2.3 and the power switch is turned on. The elapsed time meter is activated and the start time recorded. The flow (Magnehelic setting) is adjusted, if necessary using the flow control valve.

11.6 The Magnehelic reading is recorded every six hours during the sampling period. The calibration curve (Section 9.2.7) is used to calculate the flow rate. Ambient temperature and barometric pressure are recorded at the beginning and end of the sampling period.

11.7 At the end of the desired sampling period the power is turned off and the filter and PUF cartridges are wrapped with the original aluminum foil and placed in sealed, labeled containers for transport back to the laboratory.

11.8 The Magnehelic calibration is checked using the calibration orifice as described in Section 9.2.4. If the calibration deviates by more than 10% from the initial reading the flow data for that sample must be marked as suspect and the sampler should be inspected and/or removed from service.

11.9 At least one field blank will be returned to the laboratory with each group of samples. A field blank is treated exactly as a sample except that no air is drawn through the cartridge.

11.10 Samples are stored at ∿20°C in an ice chest until receipt at the analytical laboratory, at which time they are stored refrigerated at 4°C.

12. Sample Preparation and Analysis

12.1 Sample Preparation

12.1.1 All samples should be extracted within 1 week after collection.

12.1.2 PUF cartridges are removed from the sealed con-container using gloved hands, the aluminum foil wrapping is removed, and the cartridges are placed into a 500-mL Soxhlet extraction. The cartridges are extracted for 14-24 hours at ∿4 cycles/hour with 5% diethyl ether in hexane. Extracted cartridges can be dried and reused following the handling procedures in Section 10. The quartz filter can be placed in the extractor with the PUF cartridges. However, if separate analysis is desired then one can proceed with 12.1.3.

12.1.3 If separate analysis is desired, quartz filters are placed in a 250-mL Soxhlet extractor and extracted for 14-24 hours with 5% diethyl ether in hexane.

12.1.4 The extracts are concentrated to 10 mL final volume using 500-mL Kuderna-Danish concentrators as described in EPA Method 608 (5), using a hot water bath. The concentrated extracts are stored refrigerated in sealed 4-dram vials having teflon-lined screw-caps until analyzed or subjected to cleanup.

12.2 Sample Cleanup

12.2.1 If only organochlorine pesticides and PCBs are sought, an alumina cleanup procedure reported in the literature is appropriate (1). Prior to cleanup the sample

extract is carefully reduced to 1 mL using a gentle steam of clean nitrogen.

12.2.2 A glass chromatographic column (2 mm ID x 15 cm long) is packed with alumina, activity grade IV and rinsed with ~20 mL of n-hexane. The concentrated sample extract (from 12.2.1) is placed on the column and eluted with 10 mL of n-hexane at a rate of 0.5 mL/minute. The eluate volume is adjusted to exactly 10 mL and analyzed as described in 12.3.

12.2.3 If other pesticides are sought, alternate cleanup procedures (e.g. Florisil) may be required. Method 608 (5) identifies appropriate cleanup procedures.

12.3 Sample Analysis

12.3.1 Sample analysis is performed using GC/ECD as described in EPA Method 608 (5). The user must consult this method for detailed analytical procedures.

12.3.2 GC retention times and conditions are identified in Table 1 for the compounds of interest.

13. GC Calibration

Appropriate calibration procedures are identified in EPA Method 608 (5).

14. Calculations

14.1 The total sample volume (V_m) is calculated from the periodic flow readings (Magnehelic) taken in Section 11.6 using the following equation.

$$V_m = \frac{Q_1 + Q_2 \ldots Q_N}{N} X \frac{T}{1000}$$

where

V_m = Total sample volume (m^3).

Q_1, $Q_2 \ldots Q_N$ = Flow rates determined at the beginning, end, and intermediate points during sampling (L/minute).

N = Number of data points averaged.

T = Elapsed sampling time (minutes).

14.2 The volume of air sampled can be converted to standard conditions (760 mm Hg pressure and 25°C) using the following equation:

$$V_s = V_m \times \frac{P_A}{760} \times \frac{298}{273+t_A}$$

where

V_s = Total sample volume at 25°C and 760 mm Hg pressure (m^3)

V_m = Total sample flow under ambient conditions (m^3)

P_A = Ambient pressure (mm Hg)

t_A = Ambient temperature (°C)

14.3 The concentration of compound in the sample is calculated using the following equation:

$$C_A = \frac{A \times V_E}{V_i \times V_s}$$

where

C_A = Concentration of analyte in the sample, $\mu g/m^3$

A = Calculated amount of material injected onto the chromatograph based on calibration curve for injected standards (nanograms)

V_i = Volume of extract injected (µL).

V_E = Final volume of extract (mL).
V_s = Total volume of air samples corrected to standard conditions (m^3).

14. Performance Criteria and Quality Assurance

This section summarizes the quality assurance (QA) measures and provides guidance concerning performance criteria which should be achieved within each laboratory.

14.1 Standard Operating Procedures (SOPs)

14.1.1 Users should generate SOPs describing the following activities as accomplished in their laboratory: 1) assembly, calibration and operation of the sampling system, 2) preparation, purification, storage and handling of sampling cartridges, 3) assembly, calibration and operation of the GC/ECD system, and 4) all aspects of data recording and processing.

14.1.2 SOPs should provide specific stepwise instructions and should be readily available to, and understood by, the laboratory personnel conducting the work.

14.2 Process, Field, and Solvent Blanks

14.2.1 One PUF cartridge and filter from each batch of approximately twenty should be analyzed, without shipment to the field, for the compounds of interest to serve as a process blank.

14.2.2 During each sampling episode at least one PUF cartridge and filter should be shipped to the field and returned, without drawing air through the sampler, to serve as a field blank.

14.2.3 During the analysis of each batch of samples at least one solvent process blank (all steps conducted but no PUF cartridge or filter included) should be

carried through the procedure and analyzed.

14.2.4 Blank levels should not exceed ∿10 ng/sample for single components or ∿100 ng/sample for multiple component mixtures (e.g. PCBs).

14.3 Collection Efficiency and Spike Recovery

14.3.1 Before using the method for sample analysis each laboratory must determine their collection efficiency for the components of interest.

14.3.2 The glass fiber filter in the sampler is replaced with a hexane-extracted wool felt filter (weight 14.9 mg/cm^2, 0.6 mm thick). The filter is spiked with microgram amounts of the compounds of interest by dropwise addition of hexane solutions of the compounds. The solvent is allowed to evaporate and filter is placed into the sampling system for immediate use.

14.3.3 The sampling system, including a clean PUF cartridge, is activated and set at the desired sampling flow rate. The sample flow is monitored for 24 hours.

14.3.4 The filter and PUF cartridge are then removed and analyzed as described in Section 12.

14.3.5 A second sample, unspiked is collected over the same time period to account for any background levels of components in the ambient air matrix.

14.3.6 A third PUF cartridge is spiked with the same amounts of the compounds used in 14.3.2 and extracted to determine analytical recovery.

14.3.7 In general analytical recoveries and collection efficiencies of 75% are considered to be acceptable method performance.

14.3.8 Replicate (at least triplicate) determinations of collection efficiency should be made. Relative standard deviations for these replicate determinations of ± 15% or less is considered acceptable performance.

14.3.9 Blind spiked samples should be included with sample sets periodically, as a check on analytical performance.

14.4 Method Precision and Accuracy

Typical method recovery data are shown in Table 1. Recoveries for the various chlorobiphenyls illustrate the fact that all components of an Arochlor mixture will not be retained to the same extent. Recoveries for tetrachlorobiphenyls and above are generally greater than 85% but di- and trichloro homologs may not be recovered quantitatively.

REFERENCES

1. Lewis, R. G., Brown, A. R., and Jackson, M. D., "Evaluation of Polyurethane Foam for Sampling of Pesticides, Polychlorinated Biphenyls, and Polychlorinated Naphthalenes in Ambient Air", Anal. Chem. 49, 1668-1672, 1977.

2. Lewis, R. G. and Jackson, M. D., "Modification and Evaluation of a High-Volume Air Sampler for Pesticides and Semivolatile Industrial Organic Chemicals", Anal. Chem. 54, 592-594, 1982.

3. Lewis, R. G., Jackson, M. D., and MacLeod, K. E., "Protocol for Assessment of Human Exposure to Airborne Pesticides", EPA-600/2-80-180, U.S. Environmental Protection Agency, Research Triangle Park, NC, 1980.

4. Riggin, R. M., "Technical Assistance Document for Sampling and Analysis of Toxic Organic Compounds in Ambient Air", EPA-600/4-83-027., U. S. Environmental Protection Agency, Research Triangle Park, NC, 1983.

5. Longbottom, J. E. and Lichtenberg, J. J., "Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater", EPA-600/4-82-057, U. S. Environmental Protection Agency, Cincinnati, OH, 1982.

6. Bjorkland, J., Compton, B., and Zweig, G., "Development of Methods for Collection and Analysis of Airborne Pesticides." Report for Contract No. CPA 70-15, National Air Pollution Control Association, Durham, NC, 1970.

7. Annual Book of ASTM Standards, Part 11.03, "Atmospheric Analysis", American Society for Testing and Materials, Philadelphia, PA, 1983.

8. Reference Method for the Determination of Suspended Particulates in the Atmosphere (High Volume Method). Federal Register, Sept. 14, 1972 or 40CFR50 Appendix B.

TABLE 1. SELECTED COMPONENTS DETERMINED USING HI-VOL/PUF SAMPLING PROCEDURE

Compound	GC Retention Time, Minutes[a]	24-Hour Sampling Efficiency[b]	
		Air Concentration ng/m^3	% Recovery
Aldrin	2.4	0.3-3.0	28
4,4'-DDE	5.1	0.6-6.0	89
4,4'-DDT	9.4	1.8-18	83
Chlordane	(c)	15-150	73
Chlorobiphenyls			
4,4' Di-	--	2.0-20	62
2,4,5 Tri-	---	0.2-2.0	36
2,4',5 Tri-	--	0.2-2.0	86
2,2',5,5' Tetra-	--	0.2-2.0	94
2,2',4,5,5' Penta-	--	0.2-2.0	92
2,2',4,4',5,5' Hexa	--	0.2-2.0	86

(a) Data from U.S. EPA Method 608. Conditions are as follows:

Stationary Phase - 1.5% SP2250/1.95% SP-2401 on Supelcoport (100/120 mesh) packed in 1.8 mm long x 4 mm ID glass column.

Carrier - 5/95 methane/Argon at 60 mL/Minute

Column Temperature - 160°C except for PCBs which are determined at 200°C.

(b) From Reference 2.

(c) Multiple component formulation. See U.S. EPA Method 608.

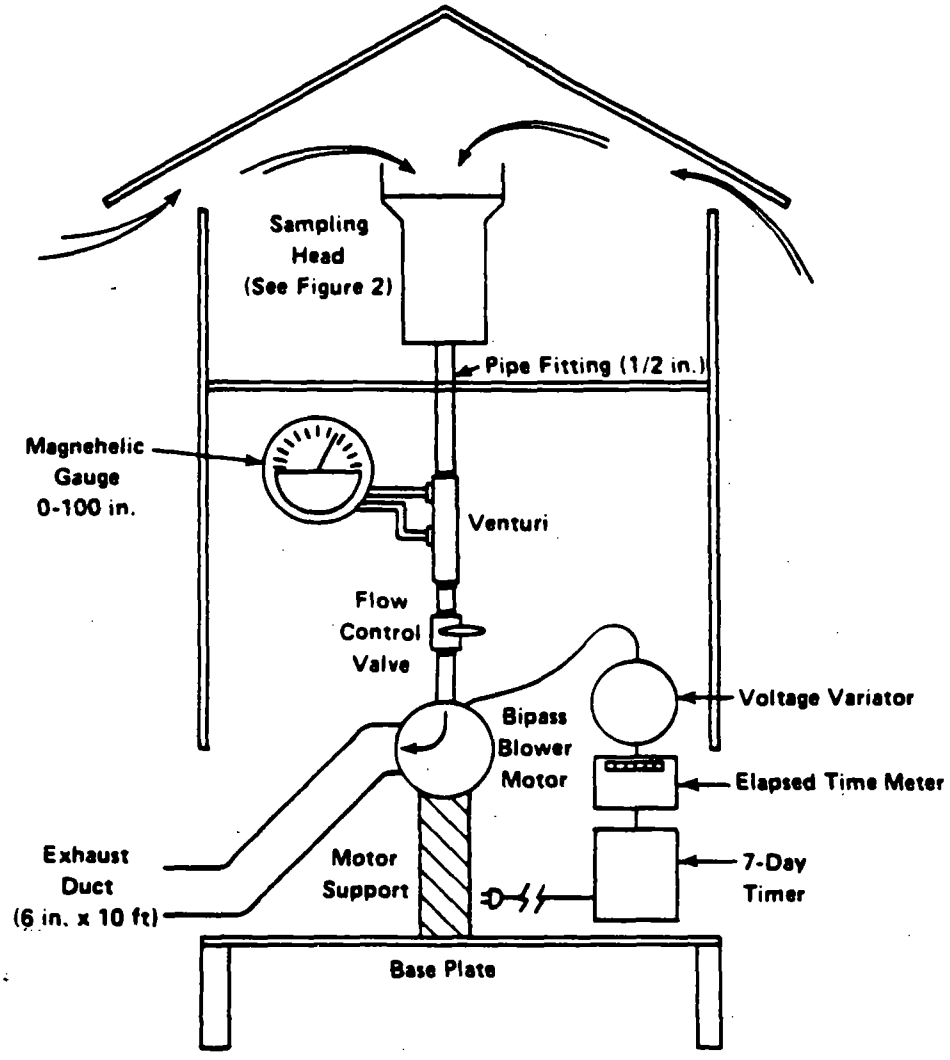


FIGURE 1. HIGH VOLUME AIR SAMPLER. AVAILABLE FROM GENERAL METAL WORKS (MODEL PS-1)

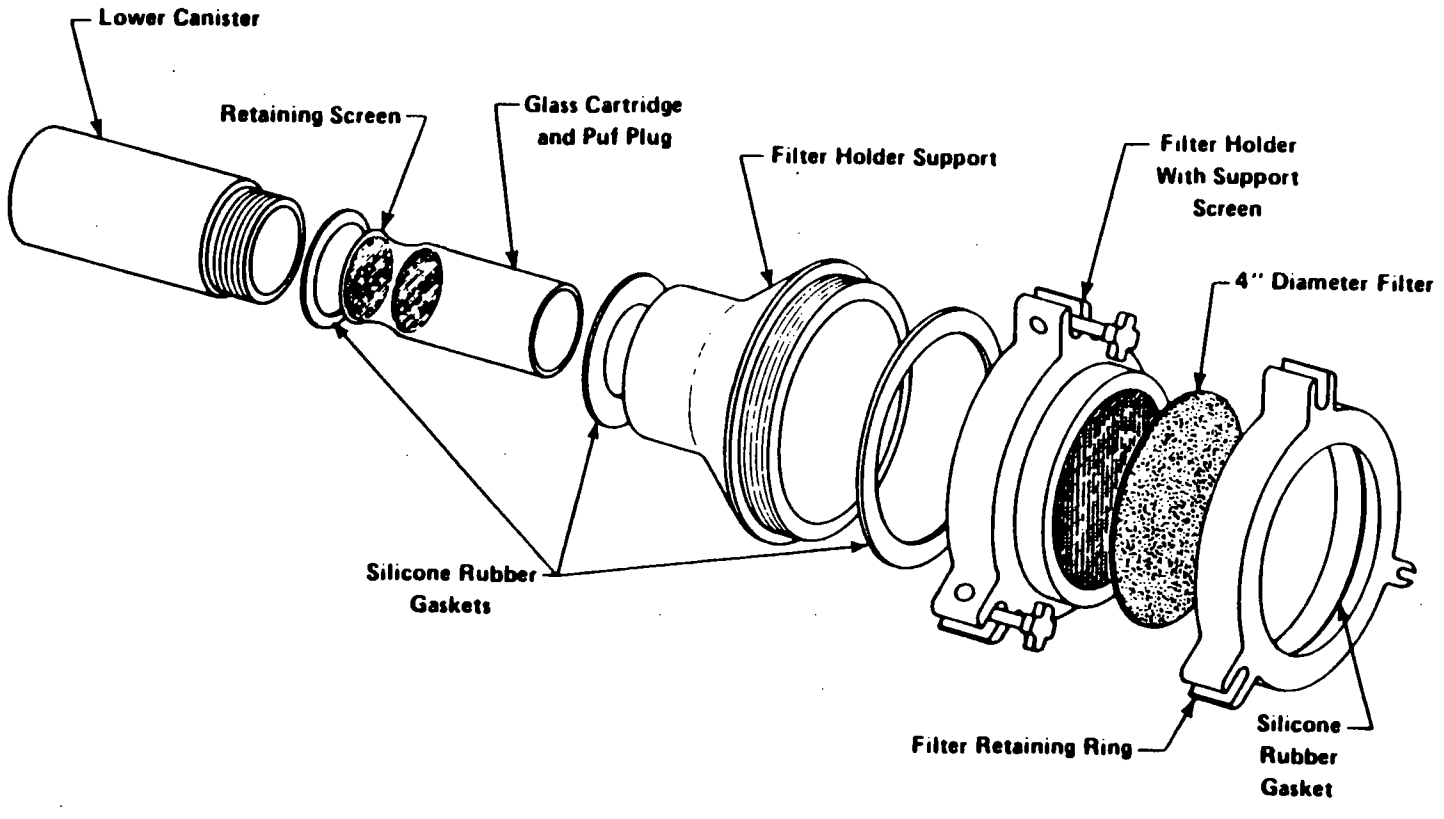


FIGURE 2. SAMPLING HEAD

Performed by_____ Calibration Orifice S/N_____ Ambient Temperature_____°C

Date/Time_____ Manometer S/N _____ Bar.Press. _____ mm Hg

Sampler S/N	Variac Setting V	Timer OK? Yes/No	Calibration Orifice Data		Sampler Venturi Data		% Difference Between Calibration and Sample Venturi Flow Rates	Comments
			Manometer, in. H_2O	Flow Rate, scm /min[a]	Magnehelic, in. H_2O	Flow Rate scm/min [b]		

(a) From Calibration Tables for Calibration Orifice or Venturi Tube

(b) From Calibration Tables for Venturi Tube in each Hi-Vol unit. Date check by_____ Date_____

FIGURE 3. TYPICAL CALIBRATION SHEET FOR HIGH VOLUME SAMPLER

Site _____ Date _____ Performed by _____

Sampler S/N	Sampling Location I.D	Rain Filter (√)	PUF Cart. No.	Vernier Setting	Clock Time			Sampler Timer			Venturi Readings Time/Magnehelic in H_2O				Ambient Temperature °C		Barometric Pressure mm Hg		Comments
					Start, hr CDT	Stop, hr CDT	Min Elapsed	Start, min	Stop, min	Min Elapsed	1	2	3	4	Start	Stop	Start	Stop	

(a) Record any evidence of tampering with sampler and/or abnormalities in sampler operation, PUF cartridge condition or handling, etc.

Data Checked By _____ Date _____

T04-20

FIGURE 4. TYPICAL SAMPLING DATA FORM FOR HIGH VOLUME PESTICIDE/PCB SAMPLER

AMBIENT AIR MONITORING
STANDARD OPERATING PROCEDURES

TITLE: Calibration of the GMW Model PS-1 Air Sampler

1. Purpose:

   To establish the response of the magnehelic gauge/venturi system used in the GMW Model PS-1 air sampler against known flowrates as measured by a GMW Model 40 orifice calibration unit.

2. Applicability:

   This procedure is applicable to the field calibration of Model PS-1 samplers over the flowrate range of 6.00 to 17.00 theoretical cubic feet per minute (tcfm). Each sampler is calibrated initially and ever six months thereafter, upon replacement of a venturi or magnehelic gauge, or when a one point flowrate audit near 8 tcfm exceeds ±10% difference.

3. Responsibilities:

   Personnel performing or evaluating field calibrations will be knowledgeable of this SOP.

4. References:

   4.1 Operating Instructions, Model PS-1 (published by General Metal Works, Inc.).
   4.2 Investigation of Flow Rate Calibration Procedures Associated with the High Volume Method for Determination of Suspended Particulates, EPA-600/4-78-047, August 1978.
   4.3 40 CFR, Part 50, Appendix B.

5. Equipment:

   5.1 GMW Model 40 orifice calibration unit with water manometer, manometer accurate to within ± 0.05 inch.
   5.2 GMW Model PS-1 sampler.
   5.3 Thermometer, accurate to within ± 0.5°C.
   5.4 Barometer, accurate to within ± 5 mmHg.

6. Procedure:

   NOTE: Record calibration data on the GMW Model PS-1 Calibration Form, see Attachment A.

6.1 Pre-calibration:

1. Obtain the atmospheric pressure (in mmHg) at the samplers location from an established meterological station.
2. Open the PS-1 sampler hood and secure it to the back latch.
3. Attach the thermometer and manometer support braces to the top edge of the shelter.
4. Attach the thermometer and manometer to their respective support braces.
5. Open both ports on the manometer by turning the L-connectors 3/4 revolution counter-clockwise, then connect a 2' section of 3/16" I.D. latex hose to one of the ports.
6. Check the manometer liquid for free movement against pressure and adjust the manometer scale to zero.

NOTE: Refer to figures 1 and 2 for identification of the sampler components.

7. Remove the polyethylene cover from the aluminum sampling module, then disconnect the module from the sampler's pneumatic line.
8. Check the meter zero on the sampler's magnehelic gauge and adjust to zero if necessary.
9. While holding the sampling module in an up-right position, unscrew and remove the lower canister from the filter holder support.
10. Hand tighten the module's filter holder support/filter holder connection.
11. Check for the presence of a gasket in the bottom of the lower canister, and also in the base of the filter holder support. If either gasket is missing, install another before proceeding.
12. Place an empty glass cartridge (2.5" O.D. x 5.25" length) in the lower canister, then reconnect the canister to the filter holder support.

Caution: Do not attempt to over-tighten the canister/filter holder support connection. Hand tighten only. Too much force will break the glass cartridge.

13. Reconnect the sampling module to the sampler's pneumatic line by applying torque only to the module's lower canister. Hand tighten only.
14. Remove the filter retaining ring from the filter holder.
15. Place the GMW Model 40 orifice calibration unit (OCU) on the filter holder and secure it to the holder by tightening the three swing bolts.

16. Fully open the sampler's ball-valve.
17. Engage the sampler's power switch, located on the Paragon timer.
18. With a screwdriver, adjust the sampler's voltage control screw (located next to the elapsed time meter) to obtain a magnehelic gauge reading of 100.
19. Plug the OCU's top opening with a No. 0 rubber stopper, and the OCU's side arm port with a finger. The sampler's magnehelic gauge should read exactly zero.

NOTE: If the magnehelic reading is above zero, then an air leak is present. Eliminate any leak before continuing. If the magnehelic display is below zero, then contact the Springfield headquarters before proceeding. Record all actions on the calibration form.

20. Upon completion of the leak check, unplug the OCU, then disengage the sampler's power switch.
21. Connect the free end of the 3/16" I.D. latex hose on the manometer to the OCU side arm port.
22. Re-engage the sampler's power switch and allow the system to warm up for 10 minutes.

6.2 Calibration:

1. Slightly close the sampler's ball valve until the magnehelic gauge is at 70. Record the magnehelic display, water manometer displacement to within ± 0.05 inch, and thermometer reading to within ± 1°C.
2. Repeat step 6.2.1 for magnehelic gauge readings at 60, 50, 40, 30, and 70 units, respectively.

Q.C. Check: If any of the following quality control limits are exceeded, then the calibration is void:
(a) The ambient temperature must be at least 5°C, but not greater than 38°C,
(b) The difference between the maximum and minimum temperature measured during the calibration cannot exceed 5°C, and
(c) The difference between the initial and final water manometer displacements (magnehelic gauge readings at 70) cannot exceed ± 0.15 inch.

TITLE: Calibration of the GMW Model PS-1 Air Sampler

6.3 Post-calibration:

1. Disengage the sampler's power switch.
2. Disconnect the latex hose from the manometer and OCU, then close the manometer ports.
3. Remove the OCU manometer, thermometer, and manometer and thermometer support braces.
4. Reattach the filter retaining ring to the filter holder.
5. Disconnect the aluminum sampling module from the sampler's pneumatic line.
6. While holding the sampling module in an up-right position, unscrew and remove the lower canister from the filter holder support.
7. Remove the empty glass cartridge from the lower canister, then reconnect the canister to the filter holder support.
8. Reconnect the sampling module to the sampler's pneumatic line.
9. Cover the sampling module with a clean polyethylene bag.
10. Close and secure the shelter's hood.
11. Complete the calibration form.

JB:jd/1435D/1.4/sp

GMW MODEL PS-1 CALIBRATION FORM

Name: _____ Date: _____

Site Address: _____

PS-1 Shelter No.: _____ Station Pressure: _____

GMW Model 40' OCU No.: _____

Magnehelic Gauge Reading	Manometer Reading (in. H_2O)	OCU Flow-Rate (tcfm)	Temp. (^oC)

Comments: _____

_____

_____

_____

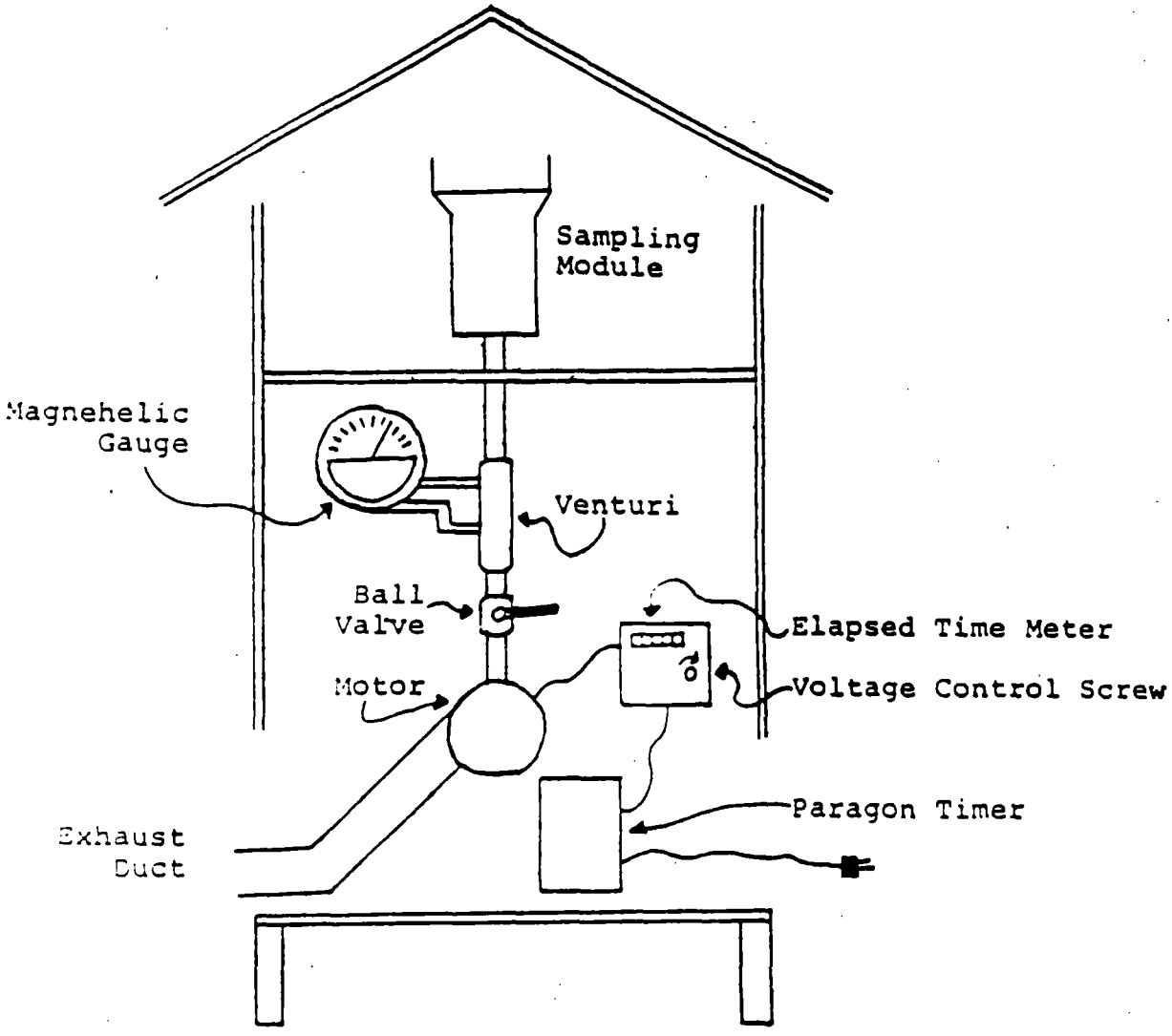


Figure 1 GMW Model PS-1 Sampler

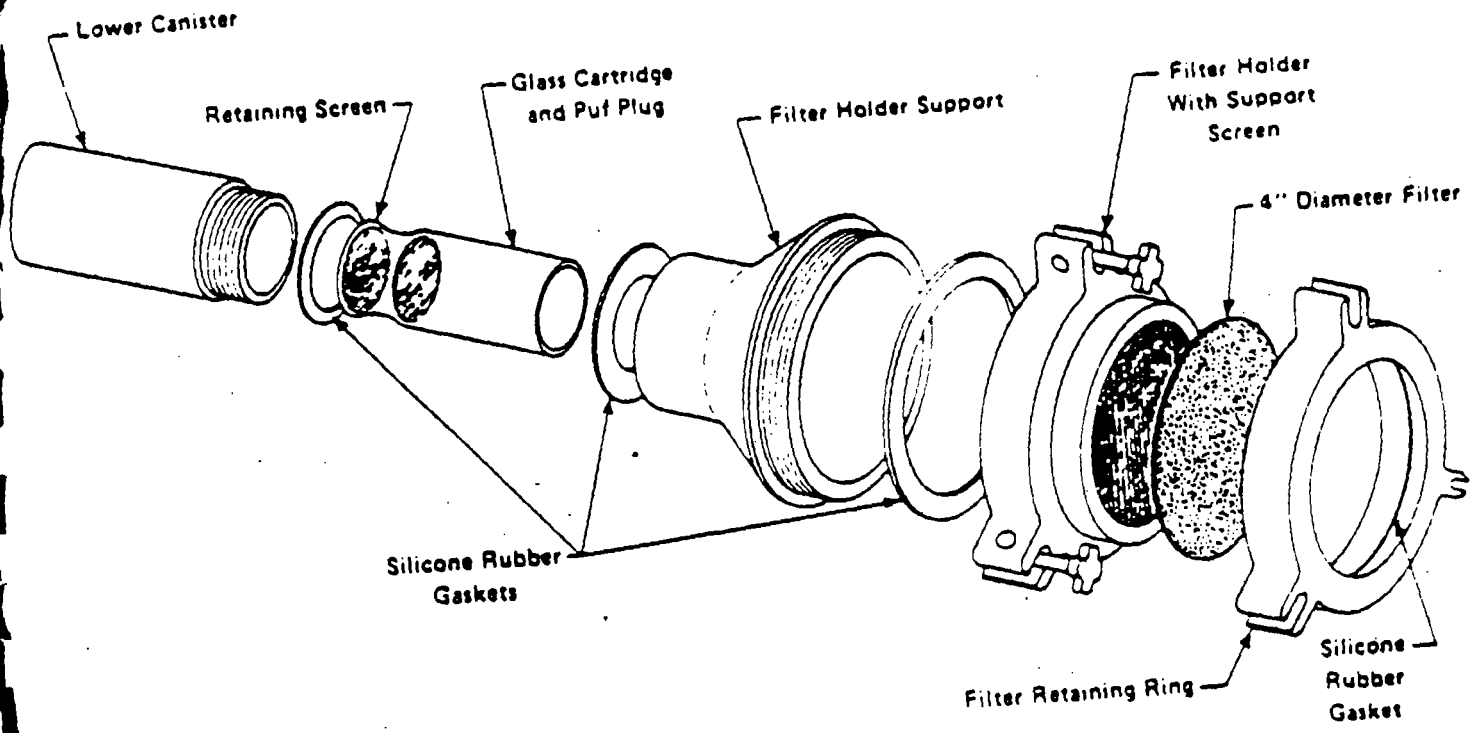


Figure 2 Sampling Module

TITLE: Operation of the GMW Model PS-1 Air Sampler

1. Purpose:

To provide for the operation of the GMW Model PS-1 air sampler in order to collect samples representative of ambient air quality.

2. Applicability:

This procedure is applicable to the on-site operation of the PS-1 sampler.

3. Responsibilities:

Personnel involved in operating and maintaining the PS-1 sampler will be knowledgeable of this SOP.

4. References:

4.1 Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, EPA-600/4-84-041, April 1984.
4.2 Manual of Analytical Methods for the Analysis of Pesticides in Humans and Environmental Samples, EPA-600/8-80-038, June 1980.

5. Equipment:

5.1 GMW Model PS-1 air sampler.

6. Procedures:

6.1 Pre-sampling activities:

NOTE: Refer to figures 1 and 2 for identification of the sampler components. Prior to initiation of the following steps, clean the module as outlined in Step No. 20 of Section 6.2.

1. Open the PS-1 sampler hood and secure it to the back latch. Also open the sampler door.
2. Check the meter zero on the sampler's magnehelic gauge and adjust to zero if necessary.
3. Remove the polyethylene cover from the aluminum sampling module, then disconnect the module from the sampler's pneumatic line.
4. Close and secure the sampler's hood and door.

5. Take the sampling module to a favorable work area, preferably an indoor location. An ice chest containing two clean sample cartridges (loaded with PUF) in their protective containers, two glass fiber filters in aluminum pouches, and a container with extra n-hexane rinsed aluminum foil should be located in the work area. The ice chest should not be cooled with ice packs at this time.
6. Unscrew and remove the sampling module's lower canister from the filter holder support.
7. Check the module's filter holder/filter holder support connection and hand tighten if necessary.
8. Check the gasket in the bottom of the lower canister, and in the base of the filter holder. Replace the gaskets if necessary.

CAUTION: Cover each hand with an unused, disposable polyethylene glove. If the gloves are not available, contact the Springfield headquarters before proceeding.

9. Open a protective container and remove the sample cartridge.
10. Unwrap the hexane rinsed aluminum foil from around the cartridge. Avoid tearing the foil as it will be needed at the end of the sampling period.
11. Slide the cartridge into the sampling module's lower canister. The end with the metal screen must be inserted first. Also note the number inscribed on the cartridge.
12. Neatly fold the aluminum foil wrapper and return it to the cartridge's protective container, then reseal the container.
13. Reconnect the sampling module's lower canister to the filter holder support. Do not attempt to over-tighten the connection since too much force will break the glass sample cartridge.
14. Record the sample cartridge number on the PS-1 Sample Information Form in the area marked "Sample Cartridge Number", see Attachment A.
15. The extra sample cartridge is designated as a trip blank cartridge. Remove the trip blank cartridge from its protective container, then unwrap the hexane rinsed aluminum foil from around the cartridge. Avoid tearing the foil as it will be needed at the end of the sampling period.
16. Note the number inscribed on the trip blank cartridge.
17. Wave the trip blank cartridge back and forth a few times, then return it to its container. Neatly fold the cartridge's aluminum foil wrapper and insert it between the cartridge and the inside of the protective container. Reseal the container.

18. Record the trip blank cartridge number on the PS-1 Sample Information Form in the area marked "Blank Cartridge Number", see Attachment A.
19. Open an aluminum pouch containing one of the clean glass fiber filters. Avoid tearing the pouch as it will be reused.
20. Wave the glass fiber filter back and forth a few times, then reinsert it back into its pouch. Reseal the pouch and place it in the ice chest. This filter is now designated as the trip blank filter.
21. Take the sampling module and the remaining unopened pouch containing the sample filter to the PS-1 sampler. You will also need a single-holed resistance plate and a silicone gasket.
22. Open the PS-1 sampler hood and secure it to the back latch. Also open the sampler's door.
23. Connect the sampling module to the samplers pneumatic line by applying torque only to the module's lower canister. Hand tighten only.
24. Remove the filter retaining ring from the module's filter holder. Place the silicone gasket on the filter holder, then position the single-holed resistance plate on top of the gasket. Place the filter retaining ring over the resistance plate and secure it to the filter holder by tightening the three swing bolts.
25. Record the elapsed time meter reading as the initial reading, then engage the sampler's power switch.
26. Plug the opening on the resistance plate with a finger. The sampler's magnehelic gauge should read exactly zero.

NOTE: If the magnehelic reading is above zero, then an air leak is present. Eliminate the leak before continuing. If the magnehelic display is below zero, then contact the Springfield headquarters before proceeding. Record all actions on the PS-1 Sample Information Form.

27. Upon completion of the leak check, disengage the sampler's power switch.
28. Remove the filter retaining ring, resistance plate, and gasket.
29. Open the aluminum pouch containing the clean glass fiber filter and remove the filter. The pouch may be discarded.
30. Center the filter, rougher side up, on the filter holder. Position the filter retaining ring over the filter and secure it to the holder by tightening the three swing bolts. Do not overtighten as the filter tends to adhere to the retaining ring.

31. Discard the used polyethylene gloves.
32. Engage the sampler's power switch and adjust the ball valve until the magnehelic gauge is near a value of 40.
33. Allow the sampler's motor to warm up for five minutes, then adjust the ball valve until the magnehelic gauge is at the value of 40 (or some other value as determined by the Springfield headquarters). A gauge value at 40 corresponds to a flowrate near 8 tcfm (theoretical cubic feet per minute).
34. Disengage the power switch and set the Paragon timer wheel to the current day and time. Also position the timer's trip pins to activate and deactivate sampling at the designated times.

NOTE: Under no circumstances may the sample cartridge be installed in the sampler for longer than 12 hours prior to the start of sampling.

35. Close and secure the sampler's hood and door.
36. Record all relevant data on the PS-1 Sample Information Form. Retain the form in a secure location.

6.2 Post-sampling activities:

NOTE: The exposed filter and cartridge must be retrieved within 6 hours after the sampling period ends.

1. Open the sampler's hood and secure it to the back latch. Also open the sampler's door.
2. Engage the sampler's power switch and allow the motor to warm up for 5 minutes, then record the magnehelic gauge display as the final reading.
3. Disengage the sampler's power switch and record the final elapsed time meter reading.
4. Disconnect the aluminum sampling module from the sampler's pneumatic line.
5. Close and secure the sampler's hood and door.
6. Take the sampling module to a favorable work area, preferably an indoor location. A cooled ice chest containing the trip blank cartridge and filter, the sample cartridge's protective container, and a container with extra hexane rinsed aluminum foil should be located in the work area.

CAUTION: Cover each hand with an unused, disposable polyethylene glove. If the gloves are not available, contact the Springfield headquarters before proceeding.

TITLE: Operation of the GMW Model PS-1 Air Sampler

7. Unscrew and remove the sampling module's lower canister from the filter holder support.
8. Open the sample cartridge's protective container, remove the aluminum foil wrapper and unfold it.
9. Slide the cartridge out of the sampling module's lower canister.
10. Rewrap the exposed cartridge with the foil and insert it into the protective container.
11. Open the container with the spare aluminum foil, remove a piece and unfold it.
12. Carefully remove the exposed glass fiber filter from the sampling module.
13. Fold the filter in half, with the exposed surface on the inside of the fold, then fold the filter in half again.
14. Wrap the folded filter with the spare aluminum foil, then place the filter in the sample cartridge container. Reseal the cartridge container.
15. Remove the trip blank cartridge from its container and wave it back and forth a few times. Rewrap the cartridge in its original foil cover and return the cartridge to its container.
16. Remove the trip blank filter from its pouch and wave it back and forth a few times. Discard the pouch.
17. Fold the filter in half twice, then wrap it with a piece of spare aluminum foil. Place the filter in the trip blank cartridge container. Reseal the trip blank and spare aluminum foil containers.
18. Discard the used polyethylene gloves.
19. Fill out sample labels (see Attachment B) for the sample and trip blank. Stick the labels on the appropriate protective containers, then return the containers to the cooled ice chest.
20. Obtain a clean, unused cloth rag and dampen it with AC grade n-hexane. Thoroughly scrub down the sampling module with the hexane moistened cloth. Then clean the sampling shelter's upper platen and inside walls with the same rag. Discard the used cloth.
21. Re-assemble the sampling module. Return the module to the PS-1, open the sampler's hood, then reconnect the module to the sampler's pneumatic line.
22. Cover the sampling module with a polyethylene bag.
23. Close and secure the sampler's hood.
24. Complete the PS-1 Sample Information Form in triplicate. Retain the original with the sample and trip blank, forward one copy to the Springfield headquarters, and file the remaining copy.
25. Repack the sample and trip blank protective containers in a cooled shipping container. Mail the cooler to the designated analytical laboratory within 24 hours after the end of sampling.

JB:bjh/sp/19130/1,5

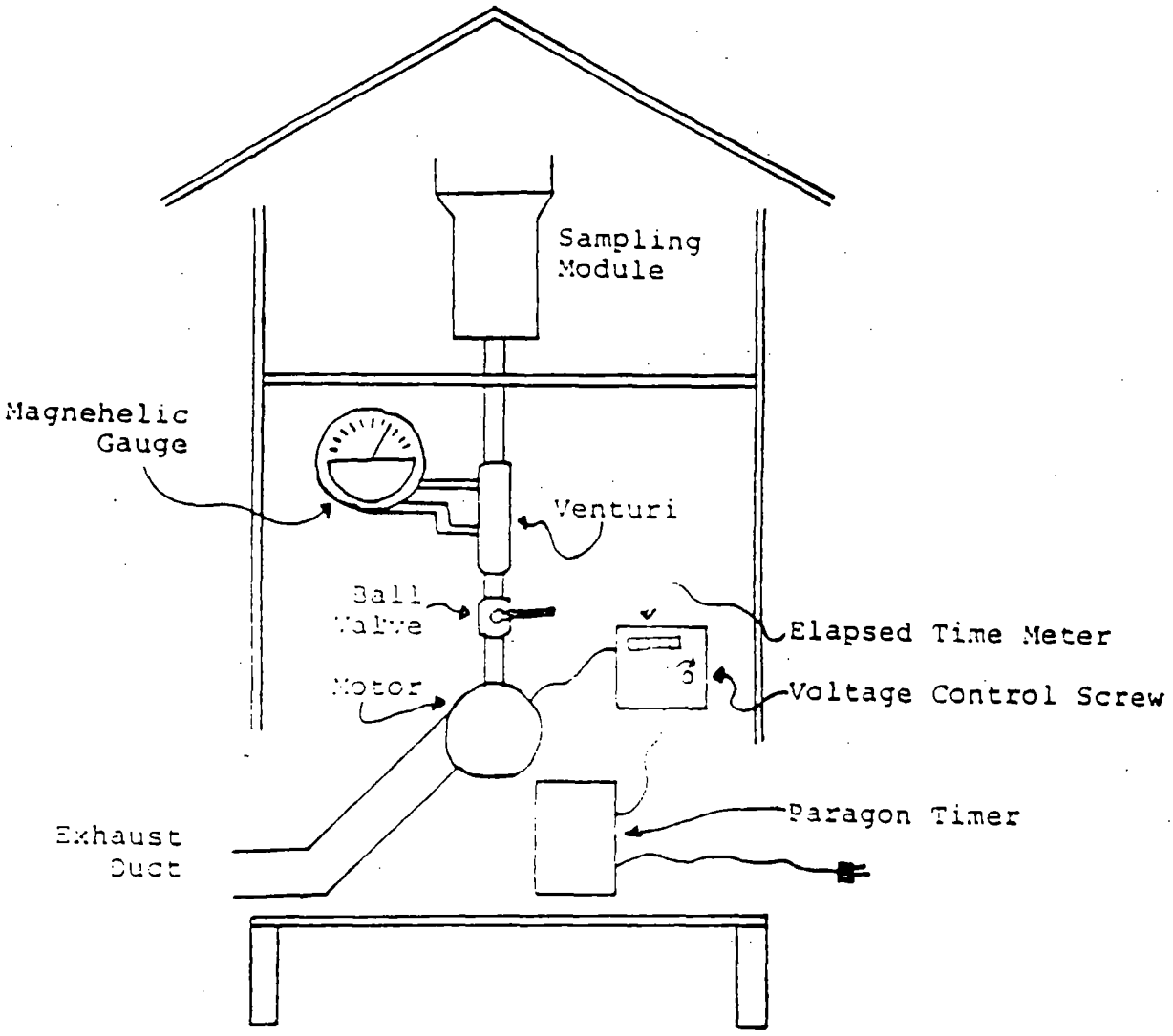


Figure 1 GMW Model PS-1 Sampler

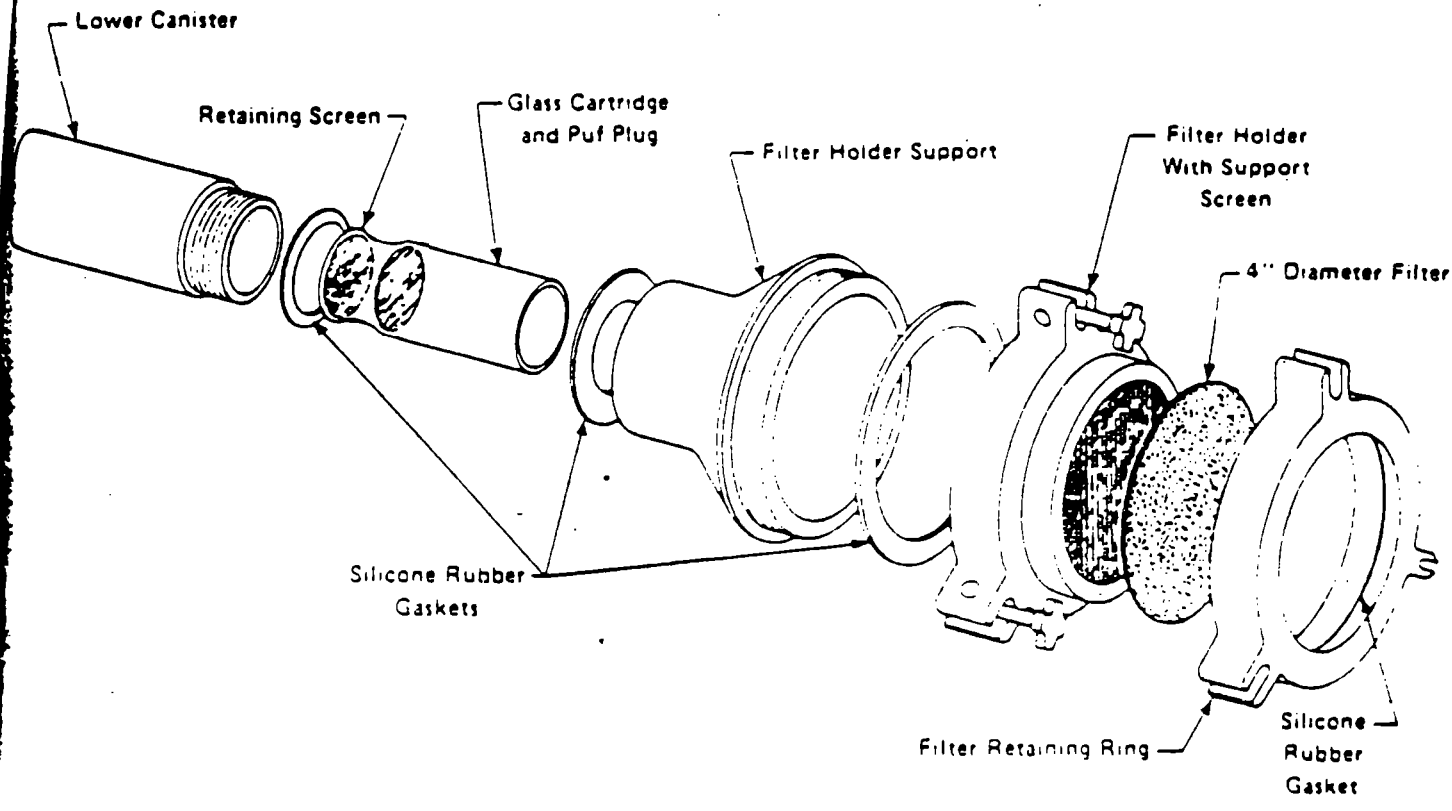


Figure 2 Sampling Module

[redacted]

[redacted]

PS-1 Sample Information Form

Sample Number:_____ Collector:_____

Sample Location:_____

Initial Elapsed Timer Reading: ☐☐☐☐☐ ☐

Final Elapsed Timer Reading: ☐☐☐☐☐ ☐

Total Elapsed Time:_____ ___min

	Initial	Final
Magnehelic Gauge Reading:	_____	_____
Flowrate:	_____tcfm	_____tcfm

Average Flowrate During Sampling:_____tcfm

Date and Time Cartridge Installed:_____ A.M. P.M. ___/___/___

Date and Time Sampling Started: _____ A.M. P.M. ___/___/___

Date and Time Sampling Stopped: _____ A.M. P.M. ___/___/___

Date and Time Cartridge Removed: _____ A.M. P.M. ___/___/___

PS-1 Sampler IEPA Number:_____

Sample Cartridge Number:_____ Blank Cartridge Number:_____

Comments:_____

_____

For Laboratory Use

_____

_____

_____

_____

_____

CHAIN OF CUSTODY RECORD

DATE	TIME	ACTION TAKEN AND SIGNATURE

BH:rd3142C/3-4

ATTACHMENT 3

RESPONSES TO USEPA'S DECEMBER 11, 1987 COMMENTS
ON THE JUNE 26, 1987 WORK PLAN

WDS 13C114-19

Chevron Chemical Company
6001 Bollinger Canyon Road, San Ramon, California
Mail Address: P.O. Box 5047, San Ramon, CA 94583-0947

February 8, 1988

FEB 1

Maryland Heights
CERCLA Investigation

Mr. Robert L. Morby
Superfund Branch
EPA Region VII
726 Minnesota Avenue
Kansas City, KS 66101

Dear Mr. Morby:

Attached is Chevron Chemical's responses to EPA's December 11, 1988 comments on the June 26, 1987 revised Work Plan for the Maryland Heights, Missouri facility.

One item is not addressed on the attachment. It concerns EPA's comment about the schedule shown in Figure 10 of the Work Plan. Figure 10 was revised to include all of the decision points listed on pages 4 and 5 of EPA's May 20, 1987 letter. These decision points, which appear in various sections of the Work Plan were not shown individually in the figure. Instead they were incorporated into the figure's main headings. This approach was approved by Mr. Steven Kinser of EPA.

Chevron requests that EPA officially approve the Work Plan. Chevron has acted in good faith to conduct the site investigation at the Maryland Heights facility and has proceeded, with EPA's encouragement, with the project even though the Work Plan has not been approved by EPA. However, we feel we can not proceed with the project without EPA approval of the Work Plan.

If you have any questions concerning these matters, please contact me at (415) 842-5882.

Sincerely,

David J. Sander

DJS/
Attachment

cc: Mr. J. D. Campbell (Woodward-Clyde Consultants)
Mr. B. E. McCullough (MODNR)
Ms. Catherine M. Barrett (EPA)

bcc: Mr. D. L. Jeffries
Mr. S. K. Knox
Mr. W. D. Moriarty
Mr. F. A. Treibel
CERCLA Files

WORK PLAN

Comment	Response
Page 8, Section 3.1.1.1	Chevron's ground water monitoring plan calls for (OWC-) 1, 12A, 14, 15, 16, 17, 18, 19, 20, 24, and 25 to be sampled and analyzed on a quarterly basis. These monitoring wells have been regularly sampled in the past because they represent locations upgradient (OWC-1) and the most downgradient possible within the potentially contaminated zone. It was felt that these wells would supply the required information for delineation of the contaminant plume. Therefore, these wells were selected for quarterly monitoring. Chevron's intention in sampling OWC-7 in November 1986 was an attempt to identify the area of maximum xylene concentration for the purpose of evaluating a proposed extraction system. The results of the analyses indicated that well OWC-7, with a xylene concentration of 160 ug/l was not located within the area of maximum xylene concentration. Therefore, the monitoring of OWC-7 was discontinued.
Page 9, Section 3.1.1.1 (Table 1)	Results from the July 1987 field investigation revealed the absence of ethylene thiourea in all 83 soil samples obtained and analyzed. Maneb was detected in eight environmental samples and two duplicates in concentrations ranging from 3 mg/kg to 22 mg/kg. Maneb was not

Comment	Response
Page 9, Section 3.1.1.1 (Table 1)	detected in sample intervals below 4.5 feet, therefore, Chevron does not believe Maneb and ethylene thiourea need to be added to the list of parameters analyzed in ground water.
Page 12, Section 3.2.1	Chevron does not believe that the sampling of existing off-site wells is necessary if the newly installed down-gradient off-site monitoring wells, OWC-24 and OWC-25, reveal no contamination or contaminant levels below their respective MCL's or other health advisory criteria. OWC-24 and OWC-25 revealed no contamination during sampling events conducted in August and September 1987. Lindane at a level of 0.53 ug/l was reported in well OWC-25 during the December 1987 quarterly ground water sampling event. Confirmation of the existence of this contaminant in well OWC-25 will take place during future ground water monitoring events. Many of the existing off-site wells identified during the off-site surveys conducted in 1981 and 1984 could not be field located. However, two off-site wells were and sampled in 1984 and analytical results indicated non-detectable levels of the contaminants of concern including 2,4,5-T, 2,4-D, and

Comment	Response
Page 12, Section 3.2.1 (cont.)	xylol at a detection limit of 1.0 ug/l, 4,4-DDD, 4,4-DDE, 4,4-DDT, aldrin, dieldrin, heptachlor, lindane, and endrin at a detection limit of 0.10 ug/l and methoxychlor, toxaphene, and chlordane at a detection limit of 5.0 ug/l. Arsenic at 0.3 ug/l and 0.1 ug/l was reported, but these low levels were attributed to natural background conditions.
Page 18, Section 5.3	Chevron will re-check OWC-21, OWC-22, and OWC-23 for a hydrocarbon layer during the next quarterly sampling event (March 1988). If a hydrocarbon layer is absent, the wells will not be checked again. If a hydrocarbon layer is observed, a sample of the material will be retained and analyzed.
Page 28, Section 7.4.1.3	Chevron believes that due to the lack of ground water use in the area, a 10^{-5} risk factor may be more appropriate.
Figure 9	OWC-24 and OWC-25 were sited based on historical water level information and ease of access (i.e. no obstructions such as buildings and/or parking lots). Due to the absence of Maneb contamination in soil below 4.5 feet (as reported based on the July 1987 field investigation results), concern over a Maneb plume does not appear warranted. Chevron believes the location of these

Comment	Response
Figure 9 (cont.)	newly installed wells will adequately investigate any potential arsenic migration.

HEALTH AND SAFETY PLAN

Comment	Response
Table 1, Page 6	The hazards associated with 2,4,5-T and DDT due to skin contact have been noted. Care was taken during the July 1987 field investigation to minimize these hazards by utilizing Tyvek and gloves taped at the wrists.
Page 13, Section 5.1	Since the contaminants of concern are primarily pesticides and do not possess a highly volatile nature, drilling in modified Level D with contingency to upgrade to Level C based on HNu readings and/or visible nuisance dust was implemented. Also, since the field work was conducted in July and heat stress was a real concern, modified Level D and Tyvek coveralls seemed appropriate to minimize the potential health effects related to heat stress.
Page 17, Section 6.2	Tyvek coveralls were disposed following use and not washed down. Respirators are cleaned and inspected daily and are never washed or cleaned while being worn. Hard hats were always removed

Comment	Response
Page 17, Section 6.2 (cont.)	prior to removing safety glasses and/or respirators.
Figure 2	Figure 2, as presented in the site specific Health and Safety Plan dated June 1, 1987, illustrates the estimated extent of on-site ground water contamination. Figure 4, as presented in the site specific Health and Safety Plan dated June 1, 1987, relates to proposed soil sampling locations for the July 1987 field investigation.

SAMPLING PLAN

Comment	Response
Page 4, Section 2.1.1.3	
(4)	Total well depth is recorded during each sampling event as standard practice. This information, coupled with the static water level, allows the volume of standing water within the well column to be calculated.
(5)	Subsequent to the installation of downgradient monitoring wells OWC-24 and OWC-25 in July 1987, purge water was discharged directly to the ground surface. Analytical results indicate that there are non-detectable or only very low levels of the constituents of

Comment	Response
(5) (cont.)	concern and placement of this water directly on the ground surface does not represent a significant health risk or contribute to additional contamination at or near the site.
(7)	The security line is always discarded between wells and no attempt is made to decontaminate the nylon rope for subsequent re-use.
(10)	A decontamination solvent was eliminated from the decontamination process in order to minimize the potential for accidental spill and/or leakage thereby enhancing potential contaminant migration. Decontamination procedures included an Alconox and water scrub, followed by a potable water rinse and a deionized water rinse. All drilling and subsurface sampling equipment were decontaminated by steam cleaning.
(12)	Bailers are carefully lowered into the wells at all times to minimize the potential loss of volatile constituents (xylene).
Page 9, Section 2.1.2.3	A decontamination blank was not collected in July 1987. However, a decontamination blank is routinely collected during each quarterly ground water monitoring event.

Comment	Response
Page 9, Section 2.1.2.3 (cont.)	Use of the decontamination solvent was eliminated as discussed in response to comment (10).

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